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MECHANISM OF THE REDUCTION OF LEAD IN GLASS

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From early times it has been known that if a lead-containing glass is held in a reducing flame the surface of the glass becomes blackened. The mechanism was represented as

$$PbO + H_2 = Pb + H_2O, \text{ and}$$
$$PbO + CO = Pb + CO_2.$$

This explanation was simple and complete in itself.

The mode of thought represented by the above equations has persisted even to the present day. In the technical literature, reference is often made in a casual manner to the reduction of lead oxide in glass to metallic lead. Thus, as late as 1941, Hull, Burger, and Navias[1] stated: "A special problem encountered in making seals with 1075 glass is the appearance of lead at the interface between glass and metal, lead oxide being reducible by ferrous metals."

In 1932 Zachariasen[2] discussed the conditions for glass-forming ability among the oxides. Warren and associates,[3] by means of Fourier analyses of x-ray patterns, described the structures of silica glass, boric oxide glass, soda-silica glass, soda-boric oxide glass, and boric oxide-silica glass. Their structures conform to the principles found to hold for crystals.[4]

On the basis of the above studies, it is clear that all glasses consist of a three-dimensional network. The glass-forming oxides, such as SiO_2 and B_2O_3, are arranged as an open network made up of ions of Si, B, and O. The coordination is triangular or tetrahedral. Between the oxygens there are holes of the correct size for a sodium ion. Similarly, ions of potassium, calcium, etc. fit into holes in the network. The addition of the modifying oxides to the pure network glasses produces a certain number of single bonded oxygens which hold the added ions in the glass. The structure is analogous to the scheme of structure in a feldspar. The existence of discrete molecules, such as SiO_2, B_2O_3, Na_2O, Na_2SiO_3, etc. is ruled out, although recent studies[5] claim, on the basis of a differential method, that alkali oxide-silica glasses contain two independent constituents, a silica glass and an alkali silicate. Even in this case, however, it is unlikely that discrete molecules exist. The entire structure of glasses, by analogy with crystals, is ionic in all respects.

The introduction of lead oxide into a glass does not alter the ionic conception. According to Bair[6] a lead oxide-silica glass is characterized by the following:

(a) Each silicon is surrounded by four oxygens. (b) The oxygens lie between two silicons or a silicon and a lead. (c) The lead ions are always separated by silicon-oxygen tetrahedra and never occur adjacent to each other or joined to each other through a common oxygen.

These structural features are in agreement with those of other glasses and crystals.

Lead, then, exists in glass in ionic form only and never as the oxide. The greater complexity of commercial lead-bearing glasses is not likely (again by analogy, this time to complex crystals) to alter the conception of a structure based entirely on anions and cations.

The chemical meaning of ions is clear. A positive ion is one which is deficient in electrons. A negative ion is one which carries an excess of electrons. The lead ions present in glasses and crystals are Pb^{2+}, and they represent lead atoms which have each lost two electrons from the outermost shell. The oxygen ions, on the other hand, are O^{2-}, which are oxygen atoms which have each acquired two valence electrons. Ions, as defined above, occur in solutions of polar compounds, in ionic crystals, in metals, and in ionized gases.

In a chemical sense the term "oxidation" means a loss or subtraction of electrons. Thus, when ferrous iron,

1. Hull, A. W., Burger, E. E., and Navias, L., *J. Appl. Physics*, 12, 704 (1941).
2. Zachariasen, W. H., *J. Am. Chem. Soc.*, 54, 3841 (1932).
3. a. Warren, B. E., and Loring, A. D., *J. Am. Ceram. Soc.*, 18, 269-76 (1935). b. Warren, B. E., Krutter, H., and Morningstar, O., *ibid.*, 19, 202-06 (1936). c. Warren, B. E., and Biscoe, J., *ibid.*, 21, 259-65 (1938). d. Warren, B. E., and Biscoe, J., *ibid.*, 21, 49-54 (1938). e. Biscoe, J., and Warren, B. E., *ibid.*, 21, 287-93 (1938). f. Biscoe, J., Robinson, C. S., and Warren, B. E., *ibid.*, 22, 180-84 (1939).
4. Bragg, W. H., and Bragg, W. L., *The Crystalline State*, Bell and Sons, London, 1933.
5. Clark, G. L., *J. Am. Ceram. Soc.*, 29, 177-86 (1946).
6. Bair, G. J., *J. Am. Ceram. Soc.*, 19, 339-47 (1936).

Fe^{2+}, is oxidized to ferric iron, Fe^{3+}, each ion loses an additional electron. Similarly, the change from Mo^{4+} to Mo^{5+} and then to Mo^{6+} is oxidation, and results from the loss of an additional electron in each case. Conversely, the term "reduction" means a gain or addition of electrons.

In the case of lead ions in glass, reduction means a change from Pb^{2+} to Pb^{0}. This is true chemical reduction since the change to metallic lead requires an acquisition of two electrons by each ion.

$$Pb^{2+} + 2e = Pb.$$

Oxygen plays no part in this reaction as it was supposed to have done in the old and outworn theory. Since lead in glass exists as the divalent lead ion, and since reduction to the metallic state merely requires the acquisition of two electrons by each ion, it remains only to determine the source of the electrons.

The necessary conditions for reduction of lead in glass are two in number.

(1) The glass and the reducing medium must be elevated to a temperature considerably above room temperature.

(2) The reducing medium must be capable of combination with oxygen to form one or more chemical compounds containing oxygen.

The function of the first condition is probably merely one of loosening the bonds which hold lead and oxygen ions in the glass. The function of the second condition is discussed later, but it is evident that reduction of lead in glass usually occurs in the presence of a burning gas, although such reduction may also occur when glass and a combustible gas are in contact at elevated temperature even when oxygen for combustion is excluded.

Pouillet[7] stated long ago that when a gas burns there is an excess of positive electricity in the bright portion of the flame where combustion is taking place, while there is an excess of negative electricity in the unburnt gas. This is another way of saying that gases in a flame are ionized. Flames of natural or manufactured gas, oxy-hydrogen flames, the alcohol flame of a spirit lamp, or a flame of carbon monoxide all produce this ionized gas.[8] It is not produced in low temperature flames such as the pale lambent flame of ether.

The reducing portion of the flame is thus found to contain unstable ions of gas, each ion carrying an excess of electrons over the number required by gas in atomic form. These can be a source of electrons for the lead ions in the surface of glass. There is a possibility too[9] that at temperatures corresponding to incandescence in solids molecules of a gas may by thermionic emission give out electrons which would move to the colder portion of the flame, making this part negative while the hotter parts become positive. Regardless of source, whether by ionization or by emission, electrons are available for reducing Pb^{2+} to Pb.

It must not be assumed that ions of gases follow the usual behavior of ions in aqueous solutions or ionic crystals. The ion H^{+} is familiar in chemistry as the positive ion in a water solution of an acid, as the positive ion in ionized water itself, etc., but the hydrogen molecule ion H_2^{+} is known to result[10] from an electrical discharge in hydrogen gas. Similarly, the oxygen molecule ion O^{+}_2 exists, as well as the positive oxygen ions O^{+} and O^{2+}. It is thus possible in ionized gases to have positive and negative ions of the familiar variety, molecule ions of the type mentioned above, and even gas in atomic form.[11]

Reduction of Pb^{2+} on the surface of the glass leaves an excess of O^{2-}. In order for the glass to be electrically neutral these negative ions must be removed, either by conversion to O_2 or by combining to form H_2O or CO_2. The end products may therefore be those represented by the old equations but the mechanism is entirely different.

In view of the necessity for a gas that can be oxidized it is possible that the oxygen in the glass plays a primary instead of a secondary role. Although the reducing portion of a flame is electrically negative there are also positive ions present. These could remove oxygen from the surface of the glass as follows:

$$2H^{+} + O^{2-} = H_2O$$
$$CO^{2+} + O^{2-} = CO_2$$

As a result of such removal the glass surface would be electrically positive because of unattached Pb^{2+}. These lead ions would acquire electrons from the negatively charged gas in order to become lead atoms.

Alternately, if atomic hydrogen and molecular carbon monoxide are assumed present in the gas, the reaction could go forward in the following manner.

$$O^{2-} + Pb^{2+} = Pb + O$$
$$2H + O = H_2O$$
$$CO + O = CO_2$$

Reduction of lead in glass by electrolysis must also be explained on the basis of the ionic nature of glass. Lead-alkali glasses are commonly used for electron tubes. Failures due to electrolysis in the glass occur in many instances, in the case, for example, of full-wave high-vacuum rectifiers. A characteristic evidence of electrolysis in these cases is a black dendritic deposit about certain wires in the glass, and this deposit is assumed, probably, correctly, to be metallic lead reduced from the lead in the glass. The chemical reaction is stated to be

$$PbO + 2Na = Pb + Na_2O.$$

A reaction such as the above is not possible in glass since no molecular lead oxide or atomic sodium is present. Yet this erroneous explanation is still used. Thus, Gallup in his informative and valuable paper[12] states that the metallic deposit is formed by the displacement of lead from the lead oxide of the glass by sodium.

The mechanism of reduction by electrolysis may be explained on a purely ionic basis that is compatible with the true structure of glass. It can be assumed that Pb^{2+} and Na^{+} are distributed almost uniformly in the glass at the beginning of electrolysis. When potential is applied between the positive and negative wires in the glass Na^{+} begins to move to the cathode. The cathode area of the glass, previously neutral, becomes positively charged because of the excess of Na^{+} over the number which the glass can hold by bonding with oxygen. The

(*Continued on page* 154)

7. Pouillet, C. S. M., *Ann. de Chim. et de Phys.*, 35, 410 (1827).
8. Thomson, J. J., and Thomson, G. P., *Conduction of Electricity Through Gases*, Cambridge Uni. Press, 1928, p. 400.
9. *Ibid.*, page 401.
10. Rice, O. K., *Electronic Structure and Chemical Binding*, New York, 1940, pp. 127ff.
11. Langmuir, I., *J. Am. Chem. Soc.*, 37, 442 (1915); *Gen. Elec. Rev.*, 29, 155 (1926).
12. Gallup, J., *J. Amer. Ceram. Soc.*, 29, 277-81 (1946).

THE ALKALI ABSORPTION OF FIRECLAY CHECKER BRICK

It is well known that material carried into checker brick settings of open hearth furnaces, blast-furnace stoves or glass tanks causes trouble from clogging of the openings and slagging of the brick if temperatures occurring in the checker chambers are high. It is not as well known that certain fluxes, chiefly alkalies, penetrate the brick structure in zones of moderate temperature and reduce the refractoriness of the checker brick to very low values. While actual failure of checker brick due to this absorption of fluxes is not common, the possibilities are always present in almost any checker setting and a knowledge of the factors involved will make it possible to avoid the occurrence of serious failures.

S. M. Swain (*Industrial Heating*, November 1946) describes a spectacular demonstration of this type of failure which occurred in the checker setting of a glass tank melting a normal soda-lime plate glass. A relatively tight setting of 9-in. straight brick had become clogged due to carry-over of batch and vapor from the glass tank. A hot repair of the checkers under No. 1 port was made by removing all of the brick, cleaning the ones that had only a loose surface deposit and returning them to the setting. Before the work could be finished on one side of the tank, the glass became colder than had been expected and it was decided to close the chamber with only the 16 courses of high-heat duty brick in place, operate the tank overnight and install the top seven courses of super-duty brick during the next working day. When the chamber was opened on the following morning, the top courses of checkers were badly bloated.

Examination of bloated brick from the top of the setting indicated that the bloating occurred in the outer surface of the brick only, the center of the brick remaining unchanged in appearance.

The composition of the bloated surface shown in Table I indicated that this surface had absorbed almost 10 per cent of alkalies and 2 per cent of lime. The sulphate radical content of 1.6 per cent indicated that only a small part of the alkalies and lime occurred as sulphates. It should be noted that these brick had been cleaned of all adhering deposit of glass-batch dust and that the surface, after cleaning, appeared to be in good condition and not altered materially by the two and one-half months' use.

Super-duty brick which had been in service in the top courses of the original setting were examined and it was noted that the amount of carry-over and the temperatures involved had caused the formation of a vitreous surface layer which did not penetrate far into the structure of the brick. The chemical composition of the surface deposit, reported as sample NA-1181 in Table I, showed that much more lime was deposited on the top checkers than on brick in the lower part of the setting and that an appreciable amount of alkalies was present in this material, as would be expected. The alumina content of 44 per cent was higher than that of the original brick and indicated that some of this glassy deposit was formed by drippings from the uptakes and upper port structure which was constructed of high alumina refractories. The

TABLE I—CHEMICAL ANALYSES OF BRICK BEFORE USE AND OF THE SURFACE ALTERED IN SERVICE

	High Heat Duty Brick as Manufactured	Bloated Surface of High Heat Duty Brick NA-1187	Super Duty Brick as Manufactured	Vitreous Surface of Super Duty Brick NA-1181
Silica, SiO_2	53.30%	45.19%	53.28%	31.32%
Alumina, Al_2O_3	41.63	36.42	42.06	44.00
Iron oxide, Fe_2O_3	0.93	0.91	0.99	1.04
Titania, TiO_2	2.20	1.85	2.17	1.20
Lime, CaO	0.36	2.03	0.28	12.32
Magnesia, MgO	0.30	0.26	0.19	0.07
Alkalies, NaKO	1.14	10.47	1.00	8.90
Arsenic, As_2O_3	n.d.	0.85	n.d.	0.20
Sulphate, SO_3	n.d.	1.62	n.d.	0.05
Total determined	99.86%	99.60%	99.97%	99.10%

fact that the alkalies did not penetrate deeply into these top checker brick, together with similar data obtained on numerous other installations, indicated that the formation of a surface glass or glaze stopped the penetration of alkalies and confined the attack to an erosive action on the surface only.

Examination of other high-heat duty brick in the lower part of the checker setting showed that there was a varying depth of penetration of alkalies as indicated by a slight change in color of the brick below the surface. It was assumed that the greatest penetration occurred in the upper parts of the checker setting where temperatures were in the neighborhood of 2000°F. and that the penetration became progressively less and the altered section thinner as the location of the brick in the original setting approached the rider arches of the flue. It was found on some of the brick examined that sufficient changes had occurred in the section penetrated by alkalies to cause this altered layer to be separated from the rest of the brick by formation of cracks.

In order to obtain some idea of the temperatures at which bloating occurred, a series of three brick were selected to show varying depths of penetration. Sample NA-1184 showed a very shallow altered layer less than 1/16 in. thick; sample NA-1185 showed a marked penetration of approximately 1/4 in. and the penetrated layer as partly separated from the body of the brick; sample NA-1186 showed a penetration of 1/4 in. with slight separation.

Sections approximately 2 1/8 in. long were cut along the center line of these brick to form several test specimens and similar pieces were cut from unused high-heat duty brick of the same shipment. One piece of each brick was placed suddenly in a furnace heated to 1500 deg. F., held at that temperature for three hours and then allowed to cool in the furnace. When this treatment caused no bloating of the samples and only minor change in color of the altered surface, a second set was placed in a furnace, heated to 1500 deg. F. and the temperature raised to 1900 deg. F., which temperature was held for three hours. Since this treatment did not make any noticeable change a third set of samples were placed in a furnace, similarly heated and the temperature raised

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INTERNATIONAL GLASS CONGRESS DISCUSSED IN PITTSBURGH

On February 11, a meeting took place in the Social Room at Mellon Institute in Pittsburgh for the purpose of discussing the possibility of an International Congress on Glass. The following fourteen persons attended the meeting: W. E. S. Turner, A. A. Wells, J. Earl Frazier, Hettinger, R. F. Brenner, J. S. Gregorius, J. C. Hostetter, H. H. Blau, D. O. Evans, R. L. Stone and Francis C. E. W. Tillotson, Samuel R. Scholes, C. B. Delgado, E. L. Flint.

The idea of a third International Congress on Glass has been given consideration for many months, but this meeting, called at the suggestion of Professor Turner, was the first concerted attempt to crystallize the industry's thinking with regard to the matter and present the pros and cons for the idea both from technological and industrial viewpoints.

In opening the discussion, Professor Turner mentioned the fact that at the second International Meeting held in London in 1936, the Germans at that time had extended the invitation for the next Congress then planned for 1939 but this, of course, was dropped. Professor Turner, in presenting his arguments for an International Congress, stressed the idea that we must build up our world connections in order mutually to learn and help each other to progress in scientific work. In this connection, it should be stated that there is an International Commission concerned with the exchange of ideas. Its American member is Dr. J. C. Hostetter; other members are Professor W. E. S. Turner, England; Dr. Maurach, Germany; Dr. Ctyroky, Czechoslovakia; Professor Andreasen, Denmark; Mr. Dudding, England; Dr. Bernard Long, France; and Mr. Jilard, Belgium.

In urging the consideration of an international meeting in the United States, Professor Turner was by no means unmindful of the many difficulties to be met and the ramifications involved in creating machinery for such a meeting. Taking note of some of the difficulties from a standpoint of European attendance, Professor Turner pointed out the current rate of exchange and the generally impoverished conditions of most of the war-torn countries from which representatives might be expected. He stated that reconstruction in the world is slower than we had thought it would be. In view of this fact and other reasons presented by American representatives present, Professor Turner suggested that the meeting at Mellon should be "merely to advance the feeling that we should have a Congress and that it certainly would take a year to get under way and possibly part of another to organize." He thought perhaps that 1949 would be a good time for serious consideration.

With regard to the other reasons presented at the meeting against any immediate planning for an International Congress, it would seem that the remarks of Dr. Hostetter more or less exemplified the attitude of those who feel that we should move cautiously in considering an international meeting. Dr. Hostetter, who has canvassed the situation, felt that the technical men all wanted the Congress, but that it was quite debatable as to whether the administrative heads of the glass industry would look favorably upon such a meeting at the present time. Although science, like art, may know no boundaries, the practical aspects of a meeting such as that being considered must be recognized; and the practicality of such a meeting is of as much importance to the foreign industrialist as it is to his American contemporary. It will take money to bring the foreign technologist to the United States, maintain him through the meeting and transport him back home. This money would have to be supplied by the foreign industrialist. For this investment, it is safe to assume he would want to be assured of some material advantage before underwriting these expenses. It is in this connection that serious doubt is held that the American glass industry could guarantee any tangible or material benefits.

No matter how ardent the technical and scientific minds in all countries may be to exchange ideas on glass, the cold hard facts of business indicate that as long as world conditions remain as unsettled as they are, the possibility of a complete and full meeting would be impractical. There is a feeling of isolationism in industry on the part of labor, as well as capital. The unstable tariff situation has contributed to this feeling and, as a result, it would seem that plant inspections by foreign visitors, a material advantage from the foreign industrialist's point of view, would not be possible in the immediate future. It was felt, however, that in all probability by 1949 this attitude would change and that industry would be more receptive to the idea of playing host to the third International Glass Congress.

Mr. Flint, who has always been a motivating force in bringing about collaboration in technical activities of the glass industry, while strongly in favor of an International Congress, in his thoughtful analysis of the ramifications of the situation, left no doubt that he concurred entirely with the majority opinion that we should move cautiously in presenting the idea. Mr. Flint succinctly summed up his position in stating that he was "pretty certain that if the Third International Congress was forced to lift its head too soon, it might receive more injury than air."

It may be reported that there was a unanimity of opinion at the Pittsburgh discussion that it would be highly impractical to go to American management now for funds, estimated at about $20,000, to conduct an International Congress in view of the present attitude of labor and management toward outside interests.

In addition to the general opinion that 1949 seemed to be a desirable time for consideration of an international meeting, it was concluded that Dr. Hostetter would call a meeting at the time of the Business Meeting of the Glass Division in Atlantic City in April for further discussion of the matter. After Dr. Hostetter introduces the subject and presents the background, it is expected that Mr. Gregorius and Dr. Blau will cover several phases of the idea. Dr. Scholes will summarize the situation for the group.

OPTICAL SYSTEM FOR TELEVISION SETS

To help speed the "age of television," a complex optical system for modern projection-type television receivers is now being manufactured by American Optical Company, Southbridge, Mass. Made of glass, the optical system consists of a spherical mirror and a Schmidt-type correcting lens which produce television pictures six times larger than pre-war sets.

The mirror and the lens, together with a cathode-ray tube, make up the heart of a modern television receiver. The telecast image is received by the cathode-ray tube and projected to the mirror which magnifies and reflects it through the correcting lens onto a flat mirror. The latter, in turn, reflects the picture onto the viewing screen.

This system of television is known as the projection type to distinguish it from electronic direct view in which the audience sees the image as received directly on the face of the cathode-ray tube.

Larger television pictures result from the projection type. For example, a cathode-ray tube only five inches in diameter produces an image which fills a screen 18 x 24 inches. Prior to the war, a direct-viewing tube, 12 inches in diameter, produced pictures about 7 x 9 inches.

The projection television system is an outgrowth of a discovery published in 1932 by Bernard Schmidt, a research assistant in a German observatory. At that time astronomical photography was unsatisfactory, due to spherical aberrations caused by the mirror used to reflect light from the stars and planets to the camera.

By placing a correcting lens (corrector plate) between the mirror and the camera, Schmidt discovered that he obtained much clearer pictures. These plates, however, had to be ground by hand, and prior to the war there were only a few in existence because of the extreme difficulty of their manufacture.

During the war, however, American Optical Company scientists developed a new method of mass producing Schmidt corrector plates and these plates were widely used in infrared viewing devices utilized by the Army and Navy for seeing in darkness. Over 50,000 of the plates were made by the optical company for military instruments and the method of manufacture is now being used for producing plates for television receivers.

Television workers engaged in polishing spherical mirrors to the highly precise specifications needed for accurate, clearly defined television reception.

After polishing and prior to aluminizing, the mirrors are next carefully cleaned by a special compound.

The use of a molded plastic corrector plate has been mentioned in the past and it has been assumed by many that it is not possible to manufacture speedily this type of lens in glass. Ordinary optical surfacing methods are capable of producing very accurate spherical or plane surfaces, but no entirely satisfactory method of grinding and polishing aspheric curves found in the corrector plate has ever been developed. This problem was solved in another way by American Optical's new method of manufacture.

The AO corrector plates, whose wave-like curves compensate for the spherical aberrations introduced into television pictures by the enlarging spherical mirror, are made by heating a flat piece of glass until it flows into the specially curved surface of a refractory on which the glass is placed. The refractory serves as a mold in some respects and is made of a special composition that does not adhere to the glass and yet permits it to assume the desired curvature. One side of the glass is then ground and polished to a plane surface.

Glass corrector plates made by this method are accurate, little affected by changes in temperature, do not warp, and resist scratches and abrasions.

The spherical mirrors produced by American Optical represent a rather large optical element to be produced in large quantities, and specialized grinding and polish-

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RECENT TRANSLATIONS OF RUSSIAN PAPERS OF INTEREST TO THE GLASS INDUSTRY

The originals of the three following papers, 1) Small Glass Tanks in Russia, 2) Manufacture of Paraboloid Reflectors in Russia, 3) The Particle Size of Anthracite Used for Reduction of Sodium Sulfate, appeared in the Russian journal, *Glass and Ceramic Industry*.

The Particle Size of Anthracite Used For Reduction of Sodium Sulfate

E. Z. Zhitomirskaya in *Stekolnaya i Keramicheskaya Promyshlennost* (Glass and Ceramic Industry) 1946, No. 1-2, p. 11, reports on the importance of the particle size of reducing agent for the manufacture of glass using sodium sulfate.

The batch used was calculated for a glass of the following composition:

SiO_2 72, Al_2O_3 2, CaO 8, MgO 2, Na_2O 16% and sodium was introduced as sodium sulfate. The melting was carried out in pots of 100 and 500 grams (0.22 and 1.1 lb.) at 1350°C. This temperature was kept on for 3 hours only as it was expected that the effect of the granulometric composition of the batch would be more marked after a short heating.

Anthracite was chosen as the reducing agent. Its amount was expressed as the ratio R of carbon to sulfur trioxide in the batch. Since the anthracite used contained about 85% of carbon and sodium sulfate contains 56% of sulfur trioxide, the ratio 0.16 means about 34 lb. of anthracite for 100 lb. of sodium sulfate, the ratio 0.19 means about 40 lb. of anthracite for 100 lb. of sodium sulfate, etc.

When anthracite was applied as a powder the particles of which were below 0.2 mm. (0.008 in.) in diameter, clear glass was obtained at the ratios R equal to 0.16 and 0.17. When the ratio was raised to 0.18 or 0.19, the glass was discolored showing the presence of non-oxidized carbon.

When anthracite was mixed in as grains 1.5 to 2 mm. in diameter (0.06 to 0.08 in.), the glass was clear at the ratio 0.152 but discolored at 0.16 and higher ratios.

When still bigger anthracite grains were employed, the glass was either not fully molten (at small ratios R) or discolored (at high ratios R).

It is seen that reduction of sodium sulfate and preparation of clear glass are more easily achieved when the particles of the reducing agent are small, and that the most favorable ratio R depends on the particle size.

Small Glass Tanks in Russia

Small glass tanks in which the area of the glass surface is less than 20 or 30 sq. meters (215 or 323 sq. feet) are increasingly used in Russia for production of special glasses (laboratory glass, lead glass, neutral glass, etc.). D. B. Ginzburg, in *Stekolnaya i Keramicheskaya Promyshlennost* (Glass and Ceramic Industry) 1946, No. 1-2, p. 3, discusses the difficulties associated with the small dimensions of these furnaces and describes 3 types worked out in Russia.

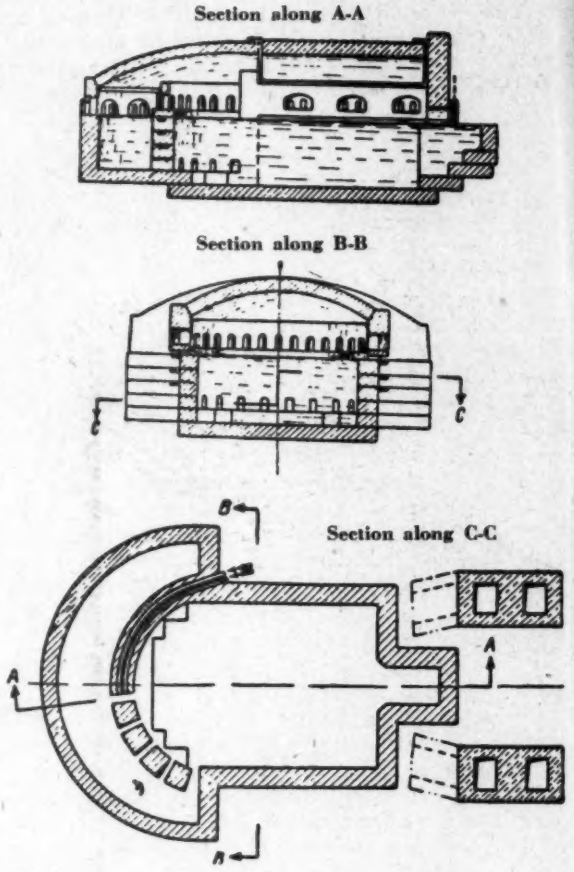


Fig. 1

Fig. 1 shows an elevation, a section and a plan of Grum-Grzhimailo's furnace. Its characteristic feature is water cooling of the bridge-wall separating the melting from the refining part of the tank. Instead of one throat the bridge-wall contains 8 windows. The melt moved chiefly through the windows nearest to the axis of the furnace, and the glass emerging from the windows far from the axis was rather impure.

Fig. 2 shows a furnace built by D. B. Ginzburg and V. P. Surovtsev (Russian pat. 21,137). In it the "bridge-wall" floats in the molten glass, and the depth of its immersion depends on the loading of the float. The depth of immersion in its turn determines the level from which glass is transferred into the refining end.

The performance of a furnace of this type can be judged from the following data. The melting part of a

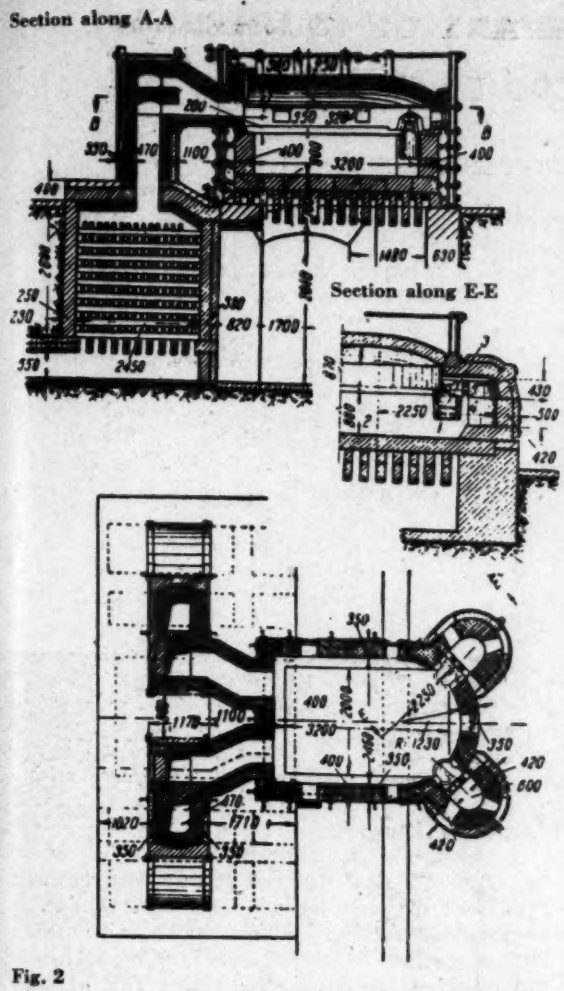


Fig. 2

typical tank was 3.2 meters long, 2.0 m. wide and 0.8 m. deep (i.e. 10.5 x 6.6 x 2.6 ft.), and its working part was 1.0 m. long, 0.5 m. wide and 0.5 m. deep (i.e. 3.3 x 1.6 x 1.6 ft.). The glass produced had the composition SiO_2 74, B_2O_3 4.5, Al_2O_3 3.5, CaO 7, Na_2O 11%.

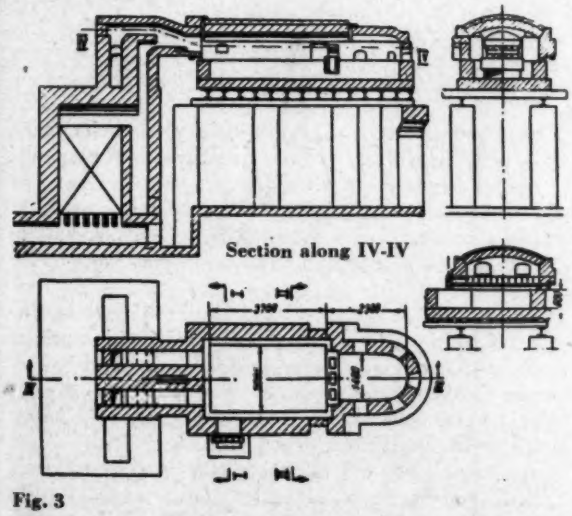


Fig. 3

The tank delivered 3.0 metric tons per 24 hours, i.e. 400 kg. per sq. meter of the glass surface in the melting end and 465 kg. per sq. meter of glass in the working end (i.e. 82 resp. 95 lb. per sq. ft.). The furnace was heated with producer gas obtained from wood and peat. About 7300 kg.-cal. were required to gain 1 kg. of glass.

Fig. 3 shows another tank built by Ginzburg. Here the working and the melting end are separated by a "boat" loosely placed on a flange in the tank wall. A checker screen separating the gas spaces above the melting and the working end is placed over the "boat." A furnace of this kind, having the melting part area of 7.5 sq. meter (80 sq. ft.), yielded 250 kg. per sq. m. of glass in the melting end per 24 hours (i.e. 51 lb. per sq. ft.). A lead glass or a dolomite glass was worked in this furnace.

Manufacture of Paraboloid Reflectors in Russia

Before the war paraboloid reflectors were manufactured in Russia by mechanical shaping of blanks which originally were 2-2.5 times as thick as the final mirror. The great original thickness was necessary because the blanks had only an approximately parabolic form. Both front and rear of the mirror required a thorough grinding.

The heavy war-time demand for small reflectors (about 250 mm. or 10 inch wide) gave impetus to research aiming at acceleration and simplification of the manufacturing procedure. This research is reviewed by Z. I. Bronstein and R. P. Fialkovskaya in *Stekol'naya i Keramicheskaya Promyshlennost'* ("Glass and Ceramic Industry"), 1946, No. 1-2, p. 8.

Considerable work was done on making paraboloids

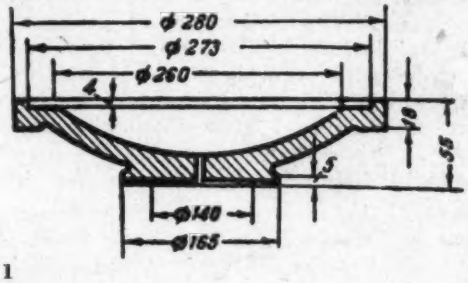


Fig. 1

by pressing. Its results were disappointing because no satisfactory glass surface could be obtained. When the press plates were of cast iron, the coarse structure of the iron left an impression on the glass. When chromium plated plates were used, the glass surfaces were contaminated with chromium.

Blowing glass in exactly dimensioned gypsum molds was equally unsuccessful. It was impossible to achieve a constant curvature along any diameter of the mirror. Wooden molds resulted in a wavy surface in addition to a variable curvature.

The method finally adopted is based on heating a blank of Fourcault sheet glass in an exact "cup" (mold). In the older method plate glass was used, but experience showed that 4 mm. (0.16 inch) thick sheet glass contains many areas good enough to be utilized for reflectors. Careful inspection of the glass is the first operation of

(*Continued on page* 150)

THE WORSHIPFUL COMPANY OF GLAZIERS OF THE CITY OF LONDON

By L. M. ANGUS-BUTTERWORTH

Early History of the Glaziers Company

The first reference to the Company of Glaziers so far discovered is in the Guildhall Records of the City of London for December, 1328. Later in the reign of Edward III the Glaziers petitioned the Mayor and Aldermen that certain ordinances might be allowed for the good of the mistery (this term was used for those men who had shown that they possessed the full knowledge or mastery of a craft). In 1368 and 1373 the election of a new Master and Wardens was recorded. We see, therefore, that the Glaziers of today are descended from a genuine mediaeval guild.

In July, 1474, there "came good men of the Mistery of Glaziers" and presented another petition to the Mayor and Aldermen asking for action to be taken against untrained men, not belonging to the Company, who were producing inferior work. Another petition of the same nature was brought forward in 1542, in the reign of Henry VIII.

In May, 1637, the fraternity of "Glaziers and Painters of Glass" applied to the State Council for incorporation. The Attorney-General was asked to certify his opinion, and in his report wrote,—"I do not discern any inconvenience if your Majesty please to incorporate the Petitioners." In June, 1637, instructions were sent to the Attorney-General from Whitehall to prepare the Grant of Incorporation. The actual Charter of Incorporation received from Charles I is dated November 6th, 1638.

Old Glaziers' Hall

It appears that towards the end of the 16th century the Glaziers had their own Hall in the Parish of St. Bennett, Ward of Castle Baynard. At the beginning of the 17th century we find the schedule of a lease of Glaziers' Hall (dated February 13th, 1601) in which the premises are described. From this we learn that, "The Hall is Boarded about with bords which are painted like Wainskott. And the same Hall is settled (furnished with settles or seats) on the South side and the next side with two bords." Descriptions follow of the furnishings "In the plor (parlour) adioyning to the Hall," in the Kitchen, etc., "In the Chamber over the Plor," and even in the Court Yard, where reference is made to "The Frame Wood over the Well and the handel of Iron to drawe water withall."

Subsequently the Glaziers' Company appears to have acquired building leases adjacent to their original property, and in an indenture of March 15th, 1624, reference is made to new buildings pertaining to the Company of Glaziers. The whole of this property was swept away in the Great Fire of 1666. It would be pleasant if at some future time the Glaziers could acquire the old property again, and erect a new Hall upon or close to the site where their ancient Guild used to meet.

Feasts

In the latter part of the 17th century, and during the 18th century, the Glaziers met at various inns and coffee houses to have their feasts and to conduct their business. These houses included the Cock Ale House in Bell Alley, the Queen's Head Tavern next to Gray's Inn Gate in Holborn, North's Coffee House in Cheapside, the Black Swan Tavern in Bartholomew Lane near the Royal Exchange, Blackwell's Coffee House in Well Court, and the Queen's Arms Tavern, St. Paul's Churchyard.

For a time meetings were held at Loriners' Hall, but conditions there were not considered satisfactory, for in September, 1752, the Court "ordered that the Company of Loriners be desired to give orders that something be done to prevent the offensive smells and smoak arising out of the Kitchen under the Court Room and annoying the Company sitting therein."

Accommodation was shared with the Loriners until 1759. On September 21st of that year a Quarterly Court was held at the Half Moon Tavern in Cheapside. It was then resolved "that this Company do quit Loriners Hall at the expiration of their lease, and do hold their Courts at this place (i.e. the Half Moon Tavern) until further notice."

The feasts of the Glaziers were impressive as regards the quantity of good things consumed at them. The following example of a menu is preserved in the Charter Box of the Glaziers' Company:

London Coffee House
Lord Mayor's Day, Nov. 9th, 1798
Dinner for the Master
Wardens, Assistants and Liverymen
of the Worshipful Company of Glaziers
Bill of Fare

6 Dishes of fine Cod boiled with Fryed Smelts round each Dish with a proper quantity of Oyster and Shrimp Sauce to each dish.
2 Fine Hams boiled weighing about 20 lbs. each.
6 Dishes of fine Fowls, one boiled and two roasted in each dish, with a proper quantity of Oyster and Gravy sauce.
1 Sirloin of Fine Beef roasted, and one Buttock of fine Beef boiled, each to weigh about 20 lbs. with a proper quantity of Pickles, Horse-Radish, Greens and Sallad.
6 Fine Turkeys roasted with a proper quantity of sausages and Gravy Sauce to each dish.
6 Dishes of fine Wild Ducks, two in each Dish, with a proper quantity of Onion and Gravy Sauce to each Dish.

4 Plumb puddings.
4 Fine Marrow Puddings.
4 Dishes of fine Mince Pies, three in each dish.
6 Dishes of fine Lobsters boiled.
6 Dishes of fine Fricassees.
4 Dozen and three quarts of Fine Red Port Wine.
2 Dozen and three quarts of Fine White Port Wine.
2 Gallons of the best Rum and two gallons of the best Brandy with a proper quantity of Oranges and Lemons and Sugar to make it into Punch.
1 Best Gloucester Cheese weighing about 8 lbs.
With a proper proportion of Greens, Potatoes, Beer, Butter, Bread, Vinegar, Oil, Pepper, Salt, Mustard, etc.
And a proper number of Knives, Forks, Plates, Dishes, Spoons, Linen Table Cloths, Napkins, Mugs and Glasses, and suitable Lights for the occasion.
And also Firing, Servants, Waiters and Attendants proper and proportionable to the said Bill of Fare.
Dinner to be ready at 4 of the Clock in the Afternoon precisely.

Conviviality was not always on quite this scale. Following business meetings a comparatively simple meal would be served. In the middle of the 18th century it was "ordered that for the Future this court do dine at the Hall on the Audit Day and that the Dinner to be provided on that day be always Two Hind Quarters of Lamb, one Peice of Beef roasted, and Two Dishes of Minced Pyes."

The Beadle

This remarkable functionary had an important part to play in the early affairs of the Glaziers' Company, and his office was no sinecure. Today the turbulent events in which the Beadle used to play his part are no longer repeated, and the duties of the post have become mainly formal and ceremonial in character. When the Beadle is appointed he swears an oath, which makes quaint reading, as the following copy will show:

The Oath of the Beadle

"You shall swear to be true and faithful to our Sovereign Lord the King's Majesty, that now is, and to his Heirs and Successors, Kings and Queens of this Realm; you shall be obedient to the Master, Wardens, and Assistants of the Company of Glaziers, London, for the Time being in all their just and lawful Commands relating to the Concerns of the said Company: you shall be attendant upon them at all their Quarter Day Courts, and other Courts, Meetings and Assemblies; you shall from Time to Time, by the Command, and according to the direction of the Master and Wardens, or any of them, summon and warn the Freemen of the said Company, and in all things incident and belonging to the Place or Office of Beadle to the said Company you shall well, faithfully, and justly demean and behave yourself. So help you God."

The first Glaziers' Beadle on record was J. Paine, who was acting in 1562, in the reign of Queen Elizabeth. After that date many entries in the Minute Books relate to the beadledom, and in the 18th century these become of particular interest. Thus the following entries will show that considerable attention was paid to the respectable appearance of the Beadle:

1707—June 30. Ordered that at the Costs of this Company a fitt and decent new Gowne be provided for the use of the Beadle in the service of this Company according to the discrecon of the Master and Wardens.

1749—Oct. 30. Ordered that a new Gowne be provided for the Beadle of this Company and that he do attend for the future every Court of Assistants in his Gowne, and that a Robemaker be desired to attend at the next Court and to bring with him patterns of several sorts and kinds of Beadle's gowns that the Court may choose one. (The miserable days of clothing coupons were still far in the future).

1750—Jan. 25. The Robemaker attended and brought the Beadle's New Gowne; and the Shag facing was disliked and ordered to be changed for the very best Shag which can be gotten and that afterwards he be paid £6. 4. 0. for the gowne. (Shag is cloth with a rough nap, and in this case has nothing to do with tobacco).

The activities of the Beadle were very varied. Thus on October 29th, 1707, it was recorded that, "This Court have ordered their Beadle to arrest George Weller as a foreigner." Just why it was an offence to be a foreigner, or how the Beadle came to have power of arrest, is not explained.

More delicate negotiations are suggested by a record of October 29th, 1711, when "It is ordered ye Renter Warden pay ye £16 owing at ye Queen's Arms Tavern and fetch away ye Master's best gowne left there by ye Beadle." Did the Beadle leave the Master's gown as security?

Sometimes the Beadle was himself arrested, and had to be rescued from prison. Thus on June 19th, 1713, the Court of the Glaziers' Company ordered "that any sum of money not exceeding 40 Shillings be advanced for obtaining the Beadle's Liberty from Ludgate Prison to attend on this Companies affairs."

Certain perquisites were attached to the office of Beadle. One was that of having what remained of the food and drink after a feast. As provision was made on a lavish scale on such occasions the amount left over was not negligible. A time came, however, when it was considered more seemly and convenient for the Beadle to be rewarded in cash. Thus on January 26th, 1778, it was "resolved that the Beadle be allowed Ten Shillings and Six Pence in lieu of the Perquisite of the Victuals remaining of the Dinner." But what did happen to the victuals left over? Did the Beadle really go away empty-handed, or did he manage to have the best of both worlds?

And there were other perquisites, both in cash and in kind. Thus the Court "ordered that the old gowns of the Master and Wardens be given to the Beadle." It was accordingly not unknown for one of the Court to wish to become Beadle, as this record shows:

April 26th, 1749. "At this Court Robert Lucas, one of the Assistants of this Company, desired to be a candidate for the office of Beadle, and being withdrawn he was called in again and acquainted by the Master, by Order of the Court, that if he should be elected Beadle of this Company he must at all times behave courteously and obligingly to all the Assistants, and in all things do as a Beadle ought to do although he is now an Assistant, and at all Courts attend without the Door unless

(*Continued on page* 146)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Improvement in Printed Copies of U. S. Patents

The United States Patent Office is gradually adopting a new idea which will be helpful to anyone interested in patents. At the end of each printed copy after the claims, the following heading will be found, "References Cited. The following references are of record in the file of this patent:". Under this is given the number, inventor's name and date of the patents cited by the Examiner during the prosecution of the application and also any printed publications which he may have relied upon as meeting any feature of the invention which may have been claimed at any time.

This will enable the reader to order copies of the references which now cost twenty-five cents each. If publications other than patents are cited, the Patent Office will furnish photostats at twenty cents per sheet.

These references are the closest prior art that the Examiner could find while the application was being prosecuted. It will sometimes happen that some references will have no bearing on the patent. The reason for this is that at some time there were claims in the patent which these references seemed to anticipate and these claims were cancelled by the attorney.

A study of the references will enable anyone familiar with the art to which the patent relates to form his own opinion as to the scope and validity of the claims. However, too much dependence should not be placed on such an opinion. A thorough examination of the patent would require a study of the file wrapper which would show just what both the Examiner and the attorney said about the references, as well as everything that took place in the prosecution of the application.

A study of the references, or even the file wrapper, by no means takes the place of a validity search made by a competent attorney. It is always possible that there are other references much closer than those found by the Examiner. The Patent Office is badly over-worked and the Examiners simply cannot devote the time that would be required for an exhaustive search of each invention. For example, the last report by the Office on the condition of pending applications showed that Division 5, which handles inventions relating to glass, had 4,117 patent applications awaiting action. The only remedy for this situation is more Examiners and better pay for them.

It is believed that this change will be appreciated by all who are interested in patents. THE GLASS INDUSTRY will report the references in connection with each patent reviewed under "Inventions and Inventors" as fast as they are printed. Up to the present, very few patents carry this list of references but it is expected that the list will appear on all patents very shortly.

Furnaces

Patent No. 2,414,545 relates to a water cooled furnace roof or crown. It was invented by William E. Moore and assigned to Delaware Engineering Corporation of Pittsburgh. This patent is a continuation-in-part of an application filed August 3, 1943 on which no patent has yet issued.

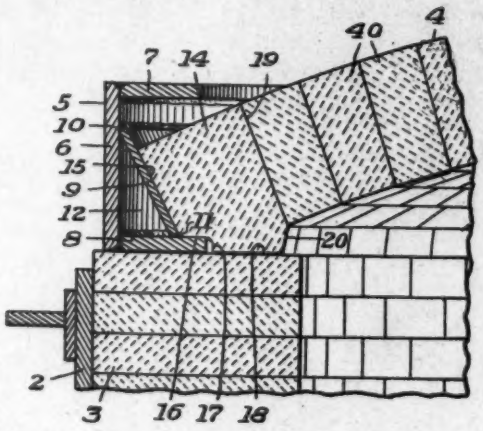


Fig. 1. Water Cooled Furnace Roof.

The invention was designed particularly for use with electric furnaces which are cylindrical in shape, but the same idea may be used with other furnaces having arched roofs. The structure shown is simple and inexpensive, but it is said to overcome many of the troubles previously encountered in water cooled roofs.

In Fig. 1 there is shown a section of a furnace wall having a metal shell 2 and refractory blocks 3. The roof 4 is enclosed by a ring 5 as the furnace shown is circular in cross-section. With furnaces of other shapes, the ring 5 would be of a corresponding shape. The ring comprises a vertical wall 6 and flanges 7 and 8, these parts being welded together. A sloping plate 9 is welded at 10 and 11 to form a chamber 12 through which cooling water may be circulated. The roof is composed of blocks 40, the outside blocks 14 being shaped to bear against the skewback 9. This block is cut away as indicated at 16 to provide a clearance 17 to allow for expansion.

Glass Compositions

Patent No. 2,414,504 is on a glass having a low power factor useful particularly as insulating laminae in electrical condensers and for sealing iron conductors into tubes of electronic devices. This is an invention of William H. Armistead who assigned it to Corning Glass Works.

Glass for this purpose should have the following characteristics: a power factor less than 0.06 per cent as measured at a frequency of one megacycle at room temperature; a dielectric constant of at least 7 or 8; a temperature coefficient for dielectric constant less than 200 parts per million per degree C. or somewhat higher for some purposes; a softening temperature not greater than 625° C; and a linear coefficient of thermal expan-

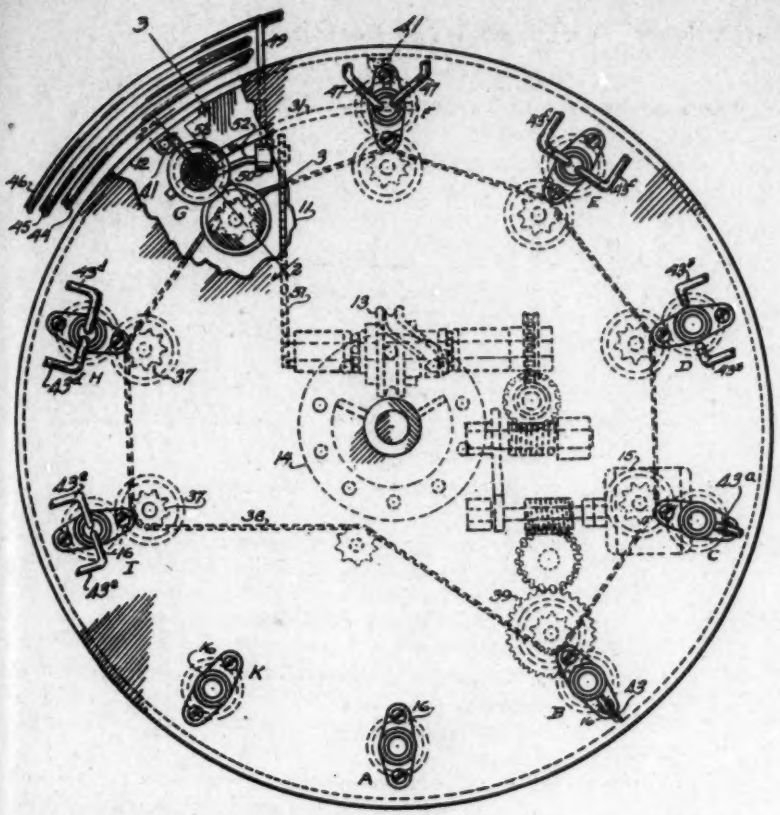


Fig. 2. Eisler Bulb Piercing Machine.

sion of about 128×10^{-7} centimeters per centimeter per degree C.

The following table gives eight examples of this new glass, calculated in per cent by weight of the batch.

	1	2	3	4	5	6	7	8
SiO_2	50	50	60.0	40.0	50.0	47.0	47.0	47.0
BaO	35	34	20.0	40.0	25.0	35.0	35.0	35.0
K_2O	10	10	12.6	12.6	15.7	12.0	11.3	10.1
Na_2O	4	4	5.4	5.4	6.8	5.1	4.9	4.3
Li_2O	1	1	2.0	2.0	2.5	.9	1.8	3.6
Na_2SiF_6	...	1	...	...	...	...	...	...
Power factor, per cent	.052	.050	.058	.041	.045	.045	.043	.046
Dielectric constant	8.0	8.0	7.7	8.4	8.4	8.1	8.1	8.1
Temperature Coefficient, P. P. M. per ° C.	132	132	...	...	...	...	...	...
Softening temp. ° C.	618	607	590	543	534	588	577	557
Expansion coeff. $\times 10^7$	117	117	119	137	136	128	128	128

The general scope of the patent is indicated by Claim 1 as follows: A glass having a power factor less than .06 per cent, a dielectric constant of at least 7 and a softening temperature less than 625° C., which consists essentially of SiO_2, BaO, K_2O, Na_2O and Li_2O, the SiO_2 being from 40 per cent to 65 per cent, BaO being from 10 per cent to 50 per cent, the total alkali metal oxides being more than 10 per cent and not less than $(10 + X)$ where X is the excess of SiO_2 over 50 per cent, the ratio K_2O/Na_2O being from 1.5/1 to 4/1, the ratio $(K_2O + Na_2O)/Li_2O$ being from 4/1 to 19/1, the glass being substantially free from Ai_2O_3.

Patent No. 2,415,661 is on a beryllium boro-phosphate glass for optical use. It is an invention of Kuan-Han Sun and Maurice L. Higgins who assigned it to Eastman Kodak Company.

This glass is clear, hard and colorless and it resists attack by air and moisture. The melting temperature is relatively low.

In the first method of preparing the batch, powdered beryllium oxide is dissolved by boiling in an aqueous solution of phosphoric acid and boric acid. The solution is then evaporated leaving a white powder.

In the second method, the beryllium oxide is dissolved by a long boiling in an aqueous solution of phosphoric acid. Evaporation yields a white powder which is mixed with powdered boron trioxide.

The powder obtained by either of these methods is at a temperature between 1300° C. and 1400° C. which forms a clear, hard, colorless glass which can be annealed at 600° C. It is to be noted that these batches attack platinum badly and the use of unglazed porcelain crucibles is recommended.

The batch compositions of seven examples follow, together with index of refraction for the D-line (n_D) and the Abbe value (v) for some of the glasses, the parts being given by weight.

Example	BeO	B_2O_3	P_2O_5	n	v
General example	12-25	2-20	65-85	—	—
I	15	2	83	—	—
II	25	5	70	1.527	67.5
III	20	5	75	1.519	69.0
IV	14	5	81	1.506	71.5
V	14	9	77	1.515	72.0
VI	13	15	72	1.519	70.5
VII	12	20	68	—	—

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,254,633	Tillyer et al	Sept. 2, 1941
2,298,746	Moulton	Oct. 13, 1942

Patent No. 2,414,633 is on a porcelain enamel for application to sheet material such as steel. It is the invention of Eugene E. Bryant who assigned it to Ferro Enamel Corporation of Cleveland, Ohio.

In order to secure a satisfactory bond between enamel and steel, it has been usual to include cobalt oxide in the enamel. This gives a good bond, but it results in a deep blue enamel making necessary a finish coat when the final color is to be white.

This invention provides a white enamel which will form a good bond with the steel and which may be ap-

plied in a single coat. The result is secured by the use of antimony and molybdenum in the batch. Using this material, an excellent white finish may be obtained with one coat having a reflectance of about 64 per cent when applied at 30 grams per square foot, dry weight.

Four examples of batch in accordance with this invention are as follows:

	Example			
	A	B	C	D
	Per cent	*Per cent*	*Per cent*	*Per cent*
Silica	12.4	12.2	16.8	16.8
Borax—dehydrated	16.4	16.0	18.8	18.8
Feldspar	25.7	25.2	17.3	17.3
Soda ash	...	...	3.3	3.3
Soda nitrate	2.1	2.1	3.5	3.5
Fluorspar	5.5	5.4	8.1	8.1
Cryolite	4.9	4.7	4.3	4.3
Barium carbonate	22.8	22.3	20.5	20.5
Calcspar	4.6	4.5	...	...
Antimony trioxide	1.3	1.3	1.2	3.4
Molybdenum trioxide	4.3	6.3	6.2	4.0

Miscellaneous Processes

Patent No. 2,414,587 is on a machine for piercing glass bulbs. It is one of a series of patents lately issued to Charles Eisler of the Eisler Engineering Company.

Fig. 2 is a plan view of the machine which is of the turret type and which performs the operations of heating the bulb at the desired points, forming protuberances at these points and then piercing the glass so that wires may be sealed into the bulb.

The machine comprises a spider 11 mounted on a suitable base and intermittently rotated by a cam 13 and disc 14 driven by a motor 15. This mechanism and the speed reducing means may be as shown in an earlier Eisler patent, No. 2,063,235. Ten bulb supports 16 are mounted for rotation on the spider 11. The friction drive which allows the supports 16 to stop rotation at certain stations is shown in Eisler patent No. 2,409,423.

The spider rotates step by step in a counter-clockwise direction as seen in the figure. At station A the bulb is placed on the support where it is held by its own weight. The bulb then advances to stations B, C, D and E where it is preheated by burners 43, 43a, 43b, and 43c which are supplied with fuel from gas, oxygen and air pipes 44, 45 and 46. At station F, the rotation of the bulb is stopped so that nozzles inside the bulb and in line with the overhead burners 47 form protuberances on the bulb.

At station G, the fire is turned off from the inside nozzles and compressed air is admitted to the nozzles from an economizer such as shown in Eisler's patent No. 1,828,493. These air jets pierce the heated glass which then passes to annealing stations H and I where the bulb is annealed by burners 43d and 43e.

Patent No. 2,414,742 is on a vehicle for ceramic pigments for making a vitreous or ceramic paint or enamel to be burned onto glassware. It is an invention of Henry A. Jackson who assigned it to Hall Laboratories, Inc. of Pittsburgh, Pa. The patent is a continuation of an application filed May 17, 1937.

The invention relates to highly viscous aqueous solutions of water-insoluble metaphosphates. The viscosity of this vehicle is greater than that of most inorganic materials and approaches that of glue, beutonite suspensions and the like. The preferred material for this use is crystalline potassium metaphosphate (KPO_3). The solution may be made by dissolving the potassium metaphosphate in an aqueous solution containing ammonium salts or salts of alkali-metals other than potassium. Lead metaphosphate may also be used and this mixes well with ceramic color. It may be applied with a brush and it forms a hard adherent film when burned to about 800° C.

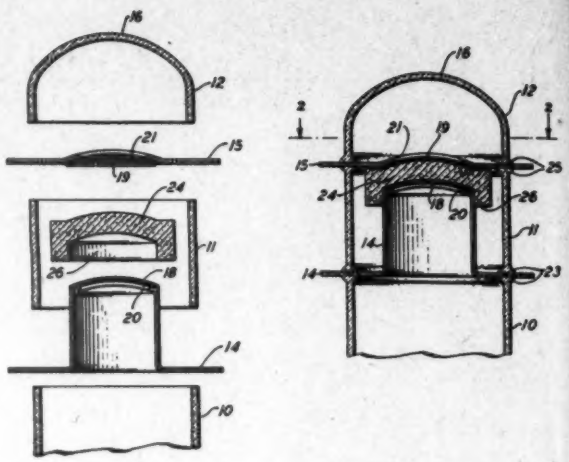


Fig. 3. Method of Making Vacuum Tubes.

Patent No. 2,415,412 is on a method of forming vacuum tubes invented by C. E. Buchwald and S. K. Shull who assigned it to Western Electric Company. The patent shows a method of securing metallic members in glass bulbs and these members, such as nush grids, can be positioned in the glass with great accuracy.

Fig. 3 shows at the left the parts to be assembled as shown at the right. There are three glass bulb portions 10, 11 and 12 and two metallic members 14 and 15 having openings 20 and 21 closed by grids 18 and 19 of finely woven wire. Note that the thickness of these parts is exaggerated in the drawing.

To assemble these parts, the bulb portions 10 and 11 are fused to the member 14 as shown at 23. The next step is to put a spacer 24 on the top of the member 14. This spacer is made of material such as sodium aluminate which is soluble in hot water. The spacer is shaped to conform to the contacting parts of the members 14 and 15. The two upper bulb portions 11 and 12 are then fused to the member 15 at 25. The spacer keeps all the delicate parts in exact position while the tube is being assembled. The spacer is then removed by dissolving it in hot water.

CORRECTION. Patent No. 2,412,925 to Stupakoff was reviewed in the January 1947 issue of THE GLASS INDUSTRY and we regret that a slight omission was made. On page 48, the word "aluminum" should be read in both instances as "aluminum oxide". It is clearly apparent that aluminum could not be used in the manner described to make synthetic jewels.

• Production of Fibreglas has been started at the new Owens-Corning plant in the Fairfax Industrial District in Kansas City, Kansas. One production line is now in use and another is expected to be ready soon. About 240 persons are employed and at least 800 will be added by next summer.

Research Digest

Glass Density Determinations by a Sink-Float Method

A sink-float apparatus and technique for determining daily glass densities had been in use for several years. The advent of the Knight apparatus and technique for density determination, being somewhat different, indicated that a comparison of the two procedures should be made in order to determine which would be best for factory control work. The results of this comparison are reported by R. D. Duff in the January 1947 issue of the *Journal of the American Ceramic Society*.

The original technique, in brief, consisted of taking a bottle sample at the same time each day from any lehr on the furnace. A seed-free ½ inch square was cut from the sidewall and reannealed by a standard procedure. The glass samples and a standard piece of glass were placed in a tube of heavy liquid which was then placed in the water bath. The bath temperature was then raised by means of an immersion heater until all pieces of glass sank to the bottom of the tube. Heating current was then turned off and the bath temperature allowed to fall at the rate of 0.1°C. per minute. At half minute intervals, the liquid in the tube was stirred vigorously with the thermometer and, after the stirring currents had died out, the motion of each piece of glass in the tube was observed. The float temperature of each piece of glass was read on the thermometer and recorded when it was observed that the piece had a tendency to rise rather than sink in the liquid, care being taken to see that the pieces were not in contact with each other or with the walls of the tube. Temperature readings were taken to the nearest 0.1°C. The difference observed between the float temperature of a sample and the float temperature of the standard is an index of the difference in density between the two. For samples lighter than the standard, the difference is positive and for samples heavier than the standard the difference is negative. Density differences in terms of temperature may be converted to density units by multiplying by the factor—0.0019.

A comparison of the two methods of observing the sink-float temperatures was first made. The results showed that the differences in the mean values observed by the two methods were small for all samples; on the average, the Knight method gave values 0.04°C. heavier. For the Knight method, the standard deviation of the 20 observations on each sample varied from 0.057°C. to 0.138°C. with an average value of 0.090°C. for all 10 samples. For the original method, the standard deviations varied from 0.050°C. to 0.094°C. with an average value of 0.074°C. for all samples. The time required by both methods was practically the same and as the original method showed slightly better precision, it was retained and used in making further comparisons on other variations in technique.

A series of tests were then made in which the samples were 1) untouched by hand 2) handled rather thoroughly and 3) scratched with a Furthite point for identification. The results of this test indicated that handling

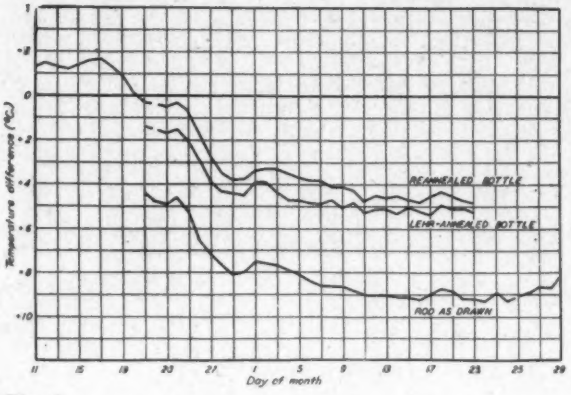


Fig. 1

and making the samples had not caused a significant change either in the mean density or in the dispersion of the individual observations about the mean.

Based on a study of samples over a month period, the following conclusions were drawn regarding the effect of commercial annealing on density: 1) In density samples from different bottles of the same temper grade, occasional density variations as large as 0.5°C. are to be expected as a result of variations in the effect of thermal history on density. 2) Annealing effects on density differ only slightly from one location to another in commercially annealed bottles. 3) On the average, one temper unit appears to be approximately equivalent to a change in density of 0.15°C.

The results of density determinations on sets of samples cut from cord-free and cordy glass ring sections indicated a poor correlation between cordiness and dispersion of the density values.

A series of tests were made on samples taken from the furnace in the form of rods. These rods were formed by a standard procedure. The results of these tests indicated that rod samples would be satisfactory for use in density determinations for the purpose of glass composition control as they represented the glass going into the bottles and the variations in density due to varying thermal history were approximately the same as were encountered in lehr annealed samples. Fig. I shows, graphically, the density of rods as drawn, the density of samples from lehr-annealed bottles, and that of reannealed bottle samples.

A test of the rod sample technique was then applied to sampling factory production for a month period. From the results of these studies, the following procedure was recommended for glass density determination made for the purpose of glass composition control: 1) Take one sample per furnace (preferably from one selected trough or fore-hearth feeding a heavy pull machine), samples to be taken at regular time intervals. 2) Use a standardized rod sampling technique for obtaining samples. 3) Determine density of the samples without reannealing by

(*Continued on page* 140)

Aerial view of the new Owens-Corning Fiberglas Corporation plant at Kansas City, Kansas. The plant entrance and offices are shown in the foreground. The large structure in the background is an assembly plant of General Motors Corporation. Other O-C plants are located in Newark, Ohio, Ashton, R. I. and Huntingdon, Pa.

O-I NEGOTIATES FOR AMERICAN COATING MILLS

Negotiations for the acquisition of American Coating Mills, Inc., one of the country's large producers of clay coated folding cartons and carbon board, by Owens-Illinois Glass Company were announced recently.

Boards of Directors of both companies have approved the acquisition and the plan has been submitted to shareholders of American Coating Mills. W. E. Levis, Chairman of the Board of Owens-Illinois, said American Coating Mills, which has plants in Elkhart and Chicago, will be operated as an independent division.

R. L. Snideman, President and General Manager of American Coating Mills, will be in charge of the division's operations. Upon the approval of the contract by shareholders and the consummation of the transaction, Mr. Snideman will become a Vice President of Owens-Illinois and a member of its Board of Directors.

THATCHER EARNINGS REPORT

At the regular January meeting of the Board of Directors of Thatcher Glass Manufacturing Company, Inc., it was announced that the 1946 net earnings would be approximately $1,674,000 after deduction of Federal Income Taxes in the amount of $988,800. This compares with the 1945 net income of $1,020,188.88 after Federal Income Taxes in the amount of $510,500.

After Convertible Preference Dividends, the 1946 earnings would be slightly in excess of $3.60 per Common Share on the 364,547 shares outstanding as of December 31, 1946. Equivalent 1945 earnings per Common Share, adjusted for the 2 for 1 Common Stock split-up and stock dividends, would have amounted to $1.67.

Net sales of approximately $18,300,000 in 1946 show an increase of approximately 33 1/3 per cent over 1945 net sales of $13,833,559.86. 1946 earnings did not include any items of consequence of a non-recurring nature. January 1947 sales are the largest of any month in the company's history and the demand for the company's products far exceeds the available productive capacity at this time.

MELVIN CLARK APPOINTED WYANDOTTE SALES MANAGER

Melvin E. Clark, former Director of Research, has been appointed a Sales Manager, according to a recent announcement made by Wyandotte Chemicals Corporation. The appointment, effective March 1, will make Mr. Clark Sales Manager for soda ash, caustic soda and bicarbonate of soda.

Mr. Clark joined the Wyandotte organization in 1941 at the time the Market Research Department was first organized in the then Michigan Alkali Company. Later the same year, he was released from the company to accept a special war assignment in Washington, where he became Chief of the Program Branch, Chemicals Bureau of the War Production Board. He returned to Wyandotte in 1944. He reorganized the activities of the Market Research Department and directed the market analysis in connection with Wyandotte's $25,000,000 expansion program.

The company has also announced the appointment of P. L. Weller as Assistant Director of Market Research. Mr. Weller has been with Wyandotte since 1945 and was formerly connected with Goodyear Tire & Rubber Co.

Mr. Weller has been active in making market surveys in the field of some of the trades served by Wyandotte Chemicals Corporation and will continue his activities along this line in addition to assuming further responsibilities in his new position.

PROFESSOR AMBERG TAKES LEAVE

Announcement has been made that Professor Charles R. Amberg, research department head at the New York State College of Ceramics at Alfred University, will take a one-year sabbatical leave starting February 1.

Professor Amberg will attend Pennsylvania State College to earn his Ph.D. degree. Planning to return to Alfred by February 1948, Professor Amberg announced that his assistant, Professor John McMahon, will head the department during his absence.

TRENTON SECTION HOLDS ANNUAL MEETING

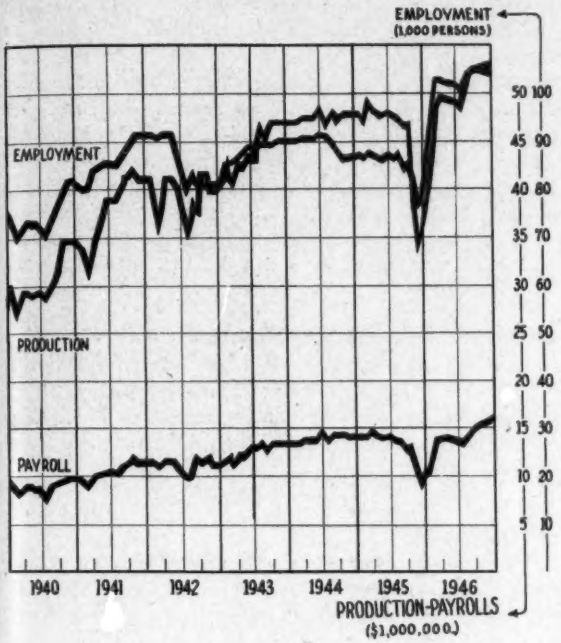
The Trenton Section of the American Ceramic Society recently held its annual meeting where election of officers for 1947 was the important business of the evening.

Officers elected were Fred A. Whitaker, Councilor; Ogden A. Kantner, Chairman; H. S. Magid, Vice Chairman; and Roland E. Tucker, Secretary-Treasurer. The program included a talk by J. A. Meister of the Mathews Conveyor Company on "Material Handling."

• Consolidated Optical Corporation of Chicago, Illinois, has just opened a new modern plant. The company's main interest will be designing and manufacturing of optical components together with the development of specialized optical instruments for special needs.

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



Activity in the glass industry during the month of December 1946 rose about 2 per cent over November, according to the Production Index. The December figure is an estimated $57,000,000 while November was an estimated $56,000,000. During December 1945, production reached an approximate $37,000,000. Production during the year 1946 has reached an estimated total of $605,500,000. This figure represents about 12 per cent over the figure for the corresponding twelve months in 1945.

Employment and payrolls: Employment in the glass industry during the month of December dropped off slightly from the 104,500 persons employed during November to 104,000 employees. However, this figure is about 31 per cent above the 78,800 persons employed during December 1945.

December 1946 payrolls increased about 2 per cent and were shown to be an estimated $16,000,000. The figure reported for November was $15,700,000. During December 1945, payrolls reached an estimated total of $10,150,000. During the entire year of 1946, glass manufacturers paid out approximately $160,500,000 in comparison with the $151,700,000 paid out during the year 1945.

Glass container production, based on figures released by the Bureau of Census, again set an all-time high within a 6-month period. Production for January 1947 was 11,154,977 gross. This figure is about 4 per cent over the previous high which was set in August 1946 with a production figure of 10,658,710 gross. The January figure also represents an approximate 19 per cent increase over the 9,341,215 gross produced during December 1946. Glass container production during January 1946 was reported at 9,844,267 gross which is about 13 per cent below January this year.

Shipments for January 1947 fell a little short of breaking the record of 10,650,866 gross also set during August 1946. January shipments were 10,405,271 gross. This is about 7 per cent over the 9,663,285 gross shipped during December 1946 and 6 per cent over the 9,766,848 gross shipped during January 1946.

Inventories on glass containers were 4,167,273 gross at the close of January 1947; 3,591,447 gross at the close of December 1946; and 4,326,485 gross at the close of January 1946.

(*Continued on next page*)

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

		Production January 1947	*Stocks January 1947*
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries & Cosmetics	Narrow Neck	3,399,492	1,747,180
	Wide Mouth	3,889,546	1,061,916
Dairy Products		362,921	150,403
Home Canning		*167,528	472,536
Beverages, Returnable		714,519	382,543
Beverages, Non-returnable		.....	.....
Beer, Returnable		860,784	57,274
Beer, Non-returnable		32,744	3,835
Liquors		1,207,632	172,674
Wines		354,860	82,916
Packers' Tumblers		164,951	35,996
Total		11,154,977	4,167,273

*This figure represents Fruits Jars only.

GLASS CONTAINER SHIPMENTS

(All figures in gross)

	January 1947
Narrow Neck Containers	
Foods	742,615
Medicinal & Health Supplies	1,141,725
Chemical, Household, Industrials	603,892
Beverages, Returnable	623,474
Beverages, Non-returnable	.....
Beer, Returnable	802,768
Beer, Non-returnable	29,533
Liquors	1,101,372
Wines	319,448
Toiletries & Cosmetics	641,574
Sub-Total (Narrow)	6,006,401
Wide Mouth Containers	
Foods	2,937,881
Dairy Products	359,115
Home Canning	*24,957
Medicinal & Health Supplies	329,147
Chemical, Household, Industrials	120,615
Toiletries & Cosmetics	182,195
Packers' Tumblers	140,483
Sub-Total (Wide)	4,094,393
Total Domestic	10,100,794
Export Shipments	304,477
Total Shipments	10,405,271

*This figure represents Fruits Jars only.

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Plate glass production, according to the Hughes Statistical Bureau, rose about 19 per cent to 21,979,614 sq. ft. during the month of January 1947. Production during December 1946 had been reported at 18,410,848 sq. ft. The January figure also represents an increase over January 1946 production which was 4,355,291 sq. ft.

Automatic tumbler production rose a little over 20 per cent for the month of January 1947. The January figure is 7,797,060 dozens as compared with 6,470,409 dozens reported for December 1946. During January 1946, production was 5,752,850 dozens. Shipments for January 1947 also rose—about 4 per cent—to 6,502,768 dozens. The December 1946 figure was 6,241,588 dozens. Shipments for the month of January 1946 were 5,515,571 dozens. Stocks on hand at the close of January 1947 are 5,088,471 as compared with 4,879,003 dozens at the end of December 1946 and 4,882,078 at the end of January 1946.

Table, kitchen and household glassware: Manufacturer's sales of machine-made table, kitchen and household glassware for the month of January 1947 practically doubled the figure reached during December 1946. The January figure is 4,430,331 as compared with 2,298,384 dozens for December—an increase of close to 93 per cent. The January 1946 figure was 4,401,963 dozens. Total sales for the period from February 1946 to January 1947 are 46,970,821 dozens.

Because of lateness, one company's figures are not included in the figures for automatic tumbler production and table, kitchen and household glassware. However, the totals for this company have been estimated for the compilation of the above figures.

RESEARCH DIGEST . . .

(*Continued from page* 137)

the original float temperature procedure. 4) The densities so determined are suitable for direct use in any desired form of control chart without correction. 5) If desired, the density values obtained on rod samples of container glasses may be approximately corrected to their expected reannealed values by adding a correction of —4.0°C. to be observed "as drawn" density values. More accurate correction figures applicable to specific glasses may be determined experimentally if desired.

OHIO STATE ESTABLISHES ENGINEERING COOPERATIVE PROGRAM

The Ohio State University industrial engineering department has established a new cooperative program with the Ohio Industrial Commission which calls for three commission members to lecture without pay at Ohio State, consult with students on engineering problems and help map a safety engineering research program.

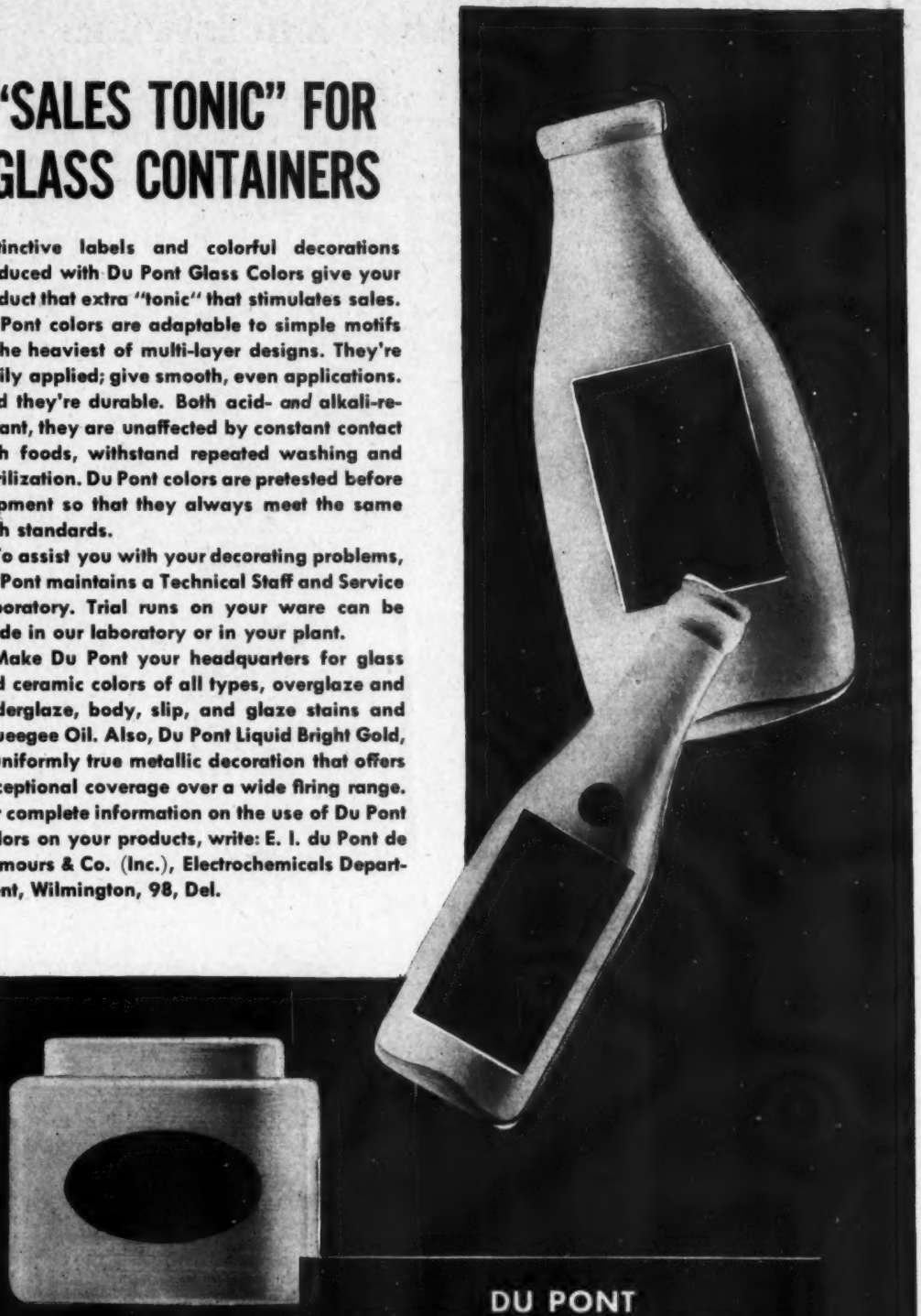
Both the commission and the university Board of Trustees have authorized the arrangement which will have the three Board members lecturing in their respective fields in the safety engineering curriculum. Commission members who will be on the campus are Lester M. Merritt, a ceramic engineer; Dr. Walter E. Obetz, M.D.; and Rufus Shockey, an attorney.

"SALES TONIC" FOR GLASS CONTAINERS

Distinctive labels and colorful decorations produced with Du Pont Glass Colors give your product that extra "tonic" that stimulates sales. Du Pont colors are adaptable to simple motifs or the heaviest of multi-layer designs. They're easily applied; give smooth, even applications. And they're durable. Both acid- *and* alkali-resistant, they are unaffected by constant contact with foods, withstand repeated washing and sterilization. Du Pont colors are pretested before shipment so that they always meet the same high standards.

To assist you with your decorating problems, Du Pont maintains a Technical Staff and Service Laboratory. Trial runs on your ware can be made in our laboratory or in your plant.

Make Du Pont your headquarters for glass and ceramic colors of all types, overglaze and underglaze, body, slip, and glaze stains and Squeegee Oil. Also, Du Pont Liquid Bright Gold, a uniformly true metallic decoration that offers exceptional coverage over a wide firing range. For complete information on the use of Du Pont Colors on your products, write: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington, 98, Del.



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NEW EQUIPMENT AND SUPPLIES

IMPROVED GLASS CIRCLE CUTTER

E. Karelsen, Inc., 125 West 45th Street, New York 19, N. Y., has announced an improved glass circle cutting machine which is said to increase efficiency and accuracy.

Among the improvements noted is a change in the arm which is now shaped to bring the top of the handle within

about 10½" of the platform. This leaves ample space for the operator's hand to insert and remove the glass to be cut. The shape of the handle has been made to fit the hand more comfortably.

The spindle or shaft is a hardened drill rod with steel bushings inserted in the cast arm. The bushings are bored, reamed and ground to a mirror finish. The head attached to the spindle for the handle is made of precision milled cast bronze with a special milling cutter, and is held in place by two machine screws. A cast bronze arm is located at the bottom of the spindle and is also precision milled and is held to the spindle by an Allen set screw.

The square bar for regulating the cutting size of circles is square cold rolled steel fitting into the arm at a true right angle with the spindle. The head attached to this bar which holds either a diamond or a wheel and a pin and has a round hole to permit adjustment to the right or left, is drilled to be at right angles to the glass. The head is fitted on a bar which is rounded on the end to allow free forward or backward adjustment. A piano wire spring and ball-bearing thrust bearings are used which reduces friction action of the spring and can be adjusted for pressure when cutting.

The glass cutting machine can be supplied to cut circles of any size up to 8", 15", 24" or 32" with base boards of corresponding size. Guides for holding the glass are furnished at additional cost.

NEW APPLICATION FOR GAS GENERATING UNIT

Vapofier Corporation, 10316 South Throop Street, Chicago 43, Ill., has made known a new application for its Vapofier gas generating unit: a means of firing atmosphere producers.

The Vapofier generates Vap-O-gas which is burned in the combustion chamber of the atmosphere producing equipment. The resulting products of combustion are then taken through condensers which remove the water vapor and the resulting atmosphere is delivered to the furnace or oven under any desired pressure.

The Vapofier gas generating unit is controlled by any standard automatic controlling instruments. The premixing equipment built into the Vapofier is an efficient method of mixing any gaseous fuel. The Vapofier occupies only two feet by four feet of space. The units are built with capacities from 70,000 to 2,000,000 B.T.U.'s per hour.

EISLER AUTOMATIC EXHAUST MACHINE

Eisler Engineering Company, 743 South 13th St., Dept. 44, Newark 3, N. J., has developed an automatic exhaust machine in models of 24, 36 and 48 positions. The 24-head type, as shown, has just been placed on the market.

Operation of the machine is continuous and fully automatic, requiring only the feeding of the glass tube and the removal of the finished lamps. It is powered by a 1/3 H.P. electric motor and production per hour ranges from 400 to 650 lamps, depending on the size of the work.

The following specifications denote some of the latest improvements put on the machine: compression (rubber type), barrel cam indexing (no Geneva gear), all metal tube connection (no rubber), exhaust tube puller, spark coil, bulb pusher, water cooling, automatic tipping torch, gas heated oven, bombarder coil lifter, bell signaling device for vacuum, lighting up arrangement and transformer, and leak detector, vacuum gauges and reducing valve.

FOXBORO DEVELOPS DYNALOG ELECTRONIC CONTROLLER

The Foxboro Company, Foxboro, Mass., has added the new Dynalog Electronic Recording Pyrometer to its line of instruments for measurement and control.

The new instrument has no galvanometer, no slide wire, no dry cell and requires no standardizing. Because of its continuous balancing action, the recording pen can traverse the full width of the chart in one second's time. Sensitivity is 1/10 of 1 per cent of the full scale range.

For applications of temperature measurement, Dynalog Instruments are available with ranges between —200°F. and +2800°F., and for use with thermocouples or electric resistance bulbs. Recorders and recording controllers are offered. A giant indicating scale for long-distance reading is an optional additional feature. In addition to temperature applications, the instruments are also in use for the measurement or control of humidity, force, strain, pH, speed and many other process variables.

CATALOGUES RECEIVED

Alten's Foundry & Machine Works, 226 West Wheeling, Lancaster, Ohio, has issued Bulletin FT-104, entitled "Temperature-Tensile Strength Test on Alten's No. 8 Alloy", which presents the results of tests recently completed by Valparaiso University under the company's sponsorship.

The tests were made in order to obtain more complete physical data relative to the behavior of Alten's No. 8 Alloy when subjected to both heat and longitudinal stress at the same time.

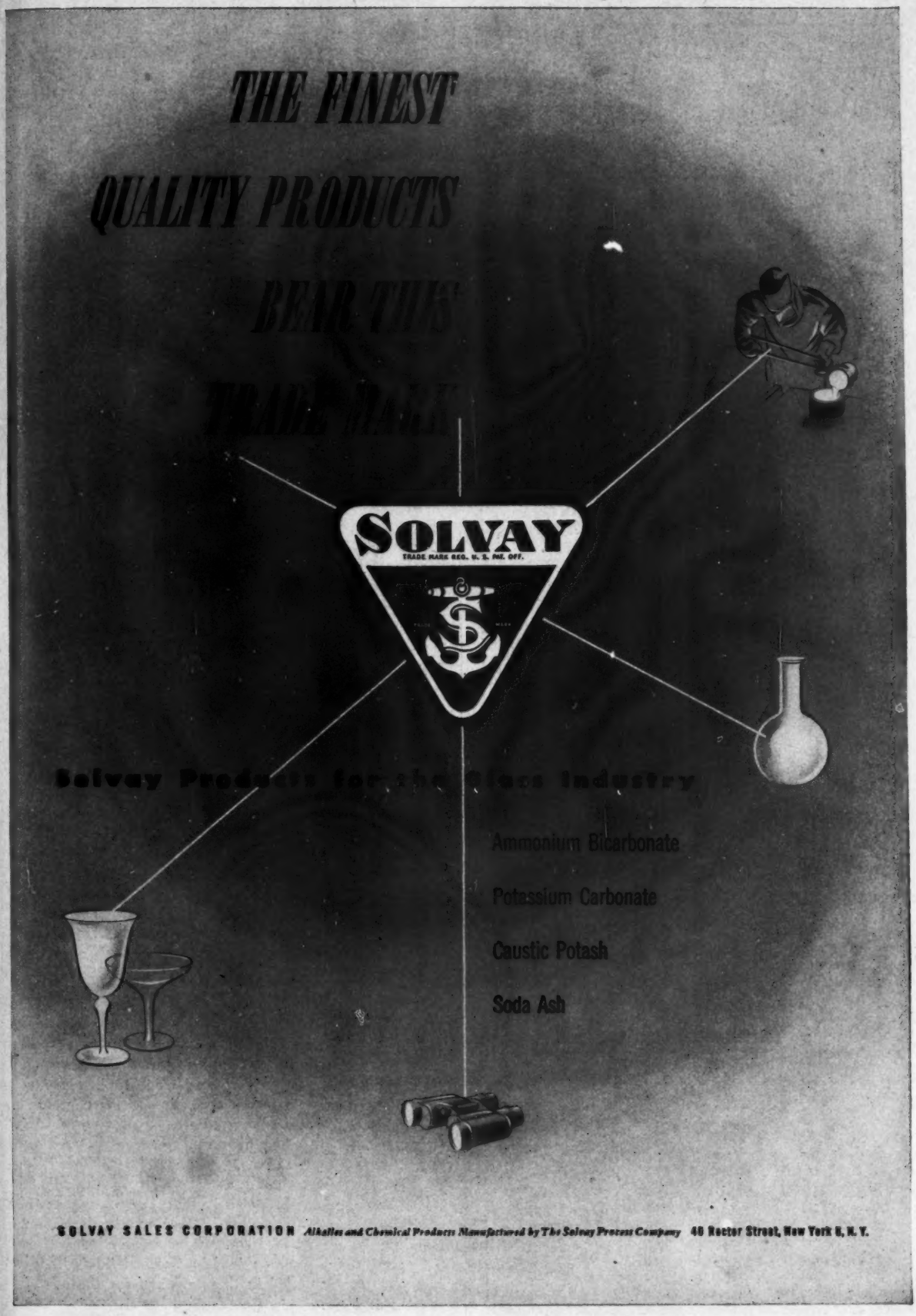
The pamphlet is well illustrated and contains various graphs and charts.

Wyandotte Chemicals Corporation, Michigan Alkali Division, Wyandotte, Mich., has issued a booklet entitled, "Report Concerning Alkali Expansion Program".

The booklet covers the company's expansion program and is issued to present some idea of when the company can deliver more soda ash or caustic. Reasons for delays and production increases are given in the booklet and photos of new plants now under construction are shown. It is hoped that the booklet will prove enlightening in view of the present alkali shortages.

The Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Ill., has published a 20-page Bulletin No. 5 on "Automatic Temperature Control Systems."

In this new bulletin, charts, tables and diagrams explain measurement and automatic control and the selection of proper control systems for process applications. Thermocouples, their placement and hints governing their use and selection of thermocouple protecting tubes are treated separately. A.S.M.E. terminology referring to processes and automatic control is also listed.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• In natural surface lake deposits located in Wyoming, just off Highway 287, midway between Casper and Rawlins; has never been accurately surveyed; high spot estimates indicate at least 500,000 tons of sulphate and 28,000 tons of carbonate waiting for development; any reasonable offer, preferably on royalty basis, will be considered; inquiries for further detail invited.

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WESTINGHOUSE LAMP DIVISION NAMES RESEARCH DIRECTOR

Announcement has recently been made of the appointment of Dr. Charles M. Slack as Director of Research for the Westinghouse Lamp Division. Dr. Slack developed an electronic tube making possible millionth-of-a-secion X-ray exposures.

Dr. Slack succeeds Dr. Harvey C. Rentschler, director of Westinghouse lamp and electronic tube research for the past 30 years. Dr. Rentschler, who is approaching retirement, will devote himself to completing certain research projects, in addition to serving in an advisory and consulting capacity.

Joining the research assistant department of the Bloomfield plant as physicist in 1927, Dr. Slack became assistant director of research in 1943. During the war, his super-speed X-ray tube was used in connection with the atomic bomb experiments and for ballistic studies at arsenals and proving grounds in America and Great Britain.

PENNSALT ADDS TO SALES FORCE

John H. Schneider, former major in the United States Army Air Force, has joined the Sales Service Staff of the Special Chemicals Division of the Pennsylvania Salt Manufacturing Company, according to a recent announcement.

Mr. Schneider, a graduate of the University of Minnesota in Aeronautical Engineering, served as a maintenance and repair officer in the 8th Air Force in the European Theater and later was assigned to an American Army team to investigate Axis aircraft developments in Germany.

BAILEY METER EXPANDS FIELD FORCE

It has recently been announced by Bailey Meter Company that it is expanding its staff of field engineers. Fourteen men are now at the company's Cleveland factory taking a six-month course in instrumentation and control. At the expiration of this course, they will join the company's field staff.

The training program, which all Bailey engineers take, gives them a firm groundwork in combustion and automatic control problems as they apply to power plants and industrial processes. R. E. Sprenkle, Director of Education, is in charge of Cadet Training.

O-I AUDIT REPORTED

Owens-Illinois Glass Company sales in 1946 were considerably higher than in any previous year of the company's history despite continuing shortage of raw materials and transportation facilities which limited production in the last six months, according to the company's audit report recently released.

Net sales and other operating revenues totaled approximately $196 million as compared to $169 million in 1945. Earnings amounted to $4.53 per share on the 2,925,364 common shares outstanding, as compared with $3.30 per share on the 2,661,204 common shares outstanding at the end of 1945. Figures for Kimble Glass Company, which was acquired by Owens-Illinois in July last year, are included in the statement for the last six months of 1946.

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GLASS PLANTS

- ENGINEERED
- DESIGNED
- CONSTRUCTED

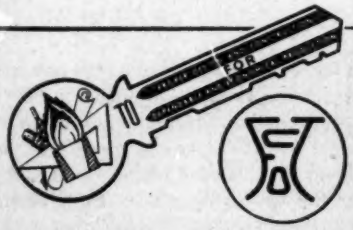
There is no sub-letting of responsibility in the Forter-Teichmann organization.

When we roll up our sleeves and attack a glass plant problem we keep them rolled up until the job is completed.

From initial survey and design to final construction and operation, Forter-Teichmann backs up its obligations with responsible action and effective results.

Whether the problem concerns the construction of complete plant, or simply special production equipment necessary to plant operation, the Forter-Teichmann Company will assume full and undivided responsibility from start to finish.

And together with its associate, Forter-Teichmann International, Forter-Teichmann ably and responsibly serves all branches of the glass industry throughout the world.



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Associate of Forter-Teichmann International

WORSHIPFUL COMPANY OF GLAZIERS . . .

(*Continued from page* 133)

called in, and then to stay no longer than was necessary and then depart, and be diligent in collecting the Quarterage of the several Members, etc."

In recent times an ex-army man has sometimes been appointed Beadle. Thus in 1918 Qr.-Master-Sergt. George F. Pittock was elected to the post.

Arms of the Glaziers Company

The Arms are: *Argent*, two glazing irons in saltire, *sable*, between four closing nails of the last. On a chief, *gules*, a lion passant guardant, *or*,

The Crest is: On a wreath of the colours a lion's head couped, *or*, between two wings expanded, *azure*.

The Supporters are: Two naked boys, *proper*, each holding in his exterior hand a long torch inflamed of the last.

The Motto is: "Lucem tuam da nobis, O Deus."

The heraldry employed has no obscure points, and is admirable in its bold simplicity, a feature common when the art was in its prime, but rare now that it is in decay.

The background of the shield is silver, and on this are two black glazing irons, (flat notched strips of iron used for breaking off small chips from the edges of sheets of glass), placed in the form of a St. Andrew's Cross. In each of the four angles formed by the crossed irons is a black closing nail. The upper third of the shield, termed the chief, is depicted red, and upon this is a lion in gold, walking with face turned full towards the observer.

The Crest repeats the lion *motif* of the coat of arms, but this time reduced to the head part, again in gold, carried between two expanded blue wings. These are mounted on a wreath, seen in section, consisting of twisted material in two colours. The colours are the red and blue used on the shield, a normal heraldic practice.

For Supporters the Glaziers have two naked boys, represented in their proper colour, as opposed to any heraldic one. They carry lighted torches, the flames of which are also in natural colours. In modern times mistaken prudishness has caused the boys to be shown partially enveloped in scarves rendered in blue. Although the flowing scarves look graceful, there is no justification for this innovation from a heraldic point of view, as the terms of the grant are perfectly explicit and definite. The Joiners' Livery Company have very similar supporters.

The Motto may be rendered "Give us light, O Lord." This is ingenious, or in addition to the figurative meaning the literal one is not without interest to those concerned with window glass. The lighted torches of the supporters are, of course, a further oblique reference to the close connection between transparent glass and the light it transmits.

When the Arms of the Glaziers Company were granted is not known, but they were recorded at Heraldic Visitations made in 1588 and 1634. The first of these official visits of inspection to the Company, in the reign of Queen Elizabeth, was by Robert Cooke, Clarencieux King of Arms. Of the second Visitation, that made in 1634, there is this record at the College of Arms:

"The Armes, Creast and Supporters of the Corporation and Fellowship of the Glaziers of the Cittie of London testified under the hand of Robert Cooke, Clarencieux King of Armes, 1588, in a peice of Vellam and now veiwed and approved in the Visitation of London, made by Sr. Hen. St. George, Kt., Richmond, 1634. At which tyme John Addison was Master and William Hide and Eusebius Pallmos wardens."

Among the references to the Arms in the Minute Books are the following:

1767—June 29. The Master acquainted the Court that Mr. John Smith, Printseller in Cheapside, had made the Company a present of a new Frame to the Picture of the Company's Arms, and had also added over the Picture a Shield with an Inscription expressing the time when this Company was incorporated and when invested with a Livery.

1766—November 9. Mr. Richard Hoar acquainted the Court that Mr. Lake Young, late Master of this Company, had made the Company a present of a very ellegant Chair, for the Master of the Company for the time being to sit in, with the Arms of the Company carved and affixed on the Top of the Back.

Recent Activities

After the first world war the Glaziers, with the fraternal assistance of the Worshipful Company of Carpenters, arranged practical classes or craftsmen in stained glass and other glazing, open to those engaged in the trade.

The Court of the Company has undertaken to develop, among other things: 1) The Registration of (a) Painters of Glass, (b) Apprentices, (c) Master Glaziers; 2) Exhibitions of modern Stained-Glass Work and of Leaded Lights, with examples of the Mediaeval and Renaissance periods; 3) Medals and prizes for the best examples of Stained-Glass and Leaded Lights; 4) Diplomas to accredited manufacturers of Stained-Glass and Leaded Lights; 5) Co-operation with the Sheffield University (Dept. of Glass Technology) in Lecture Courses for manufacturers and operatives, and for research work and training scholarships.

The Glaziers' Company is now represented on the Glass Research Delegacy of the Sheffield University.

After a period of inactivity in the middle of the 19th century, steady progress has been made in recent years, and this prosperity has been reflected in the growth of the Livery, the figures for which have been:

	Livery	*Assistants*
1875	27	10
1896	64	16
1919	110	16
1928	136	17
1946	226	20

• The Pennsylvania Salt Manufacturing Company reports that net profits for the twelve months ending December 31, 1946 after deduction for Federal Taxes are $2,077,425.61 equivalent to $2.77 per share on 750,000 shares of $10 par stock outstanding, which compares with the earnings for the twelve months ended December 31, 1945 of $1,288,329.59 or $1.72 per share.

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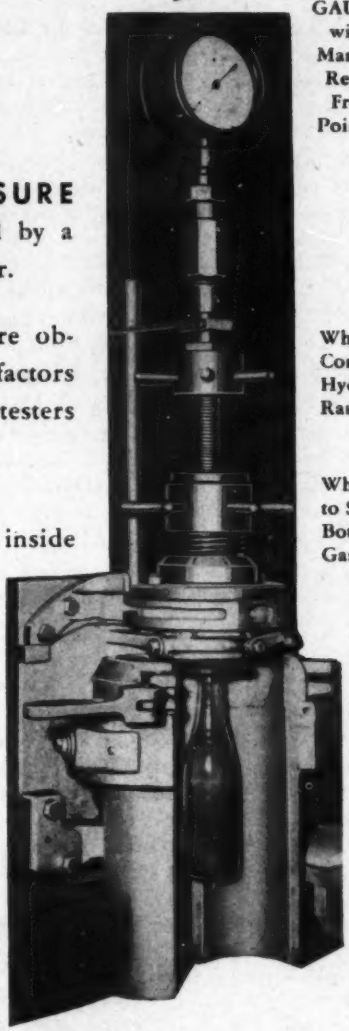
BREAKING PRESSURE is temporarily recorded by a manual reset free pointer.

ACCURATE TESTS are obtained. No increment factors are involved, as with testers using weights.

TESTING IS SAFE as the bottle breaks inside of a safety shield and the parts drop harmlessly into a container.

TESTING IS FAST as there are no weights to handle and the required operations are simple and convenient.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Latch to Lock Safety Shield

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FOR SALE

GLASS PLANT, CHICAGO HEIGHTS, ILLINOIS

By order of the United States District Court for the Northern District of Ohio, Western Division, Owens-Illinois Glass Company offers for sale as a unit all real estate, buildings, machinery, production equipment (not including molds), tanks and furnaces (except experimental machinery and furnaces) located at Chicago Heights, Illinois, and which were a part of the assets acquired by Owens-Illinois Glass Company from Kimble Glass Company on July 1, 1946.

In accordance with the order of the Court such property is offered for sale for cash to any purchaser approved by said Court, subject to prior sale, at the fair market value of said property as a glassware manufacturing plant, as determined by an appraisal made by The Lloyd-Thomas Company, which said appraisal has been duly filed with the Clerk of said Court at Toledo, Ohio., where it may be inspected. Additions and improvements made to the property described above since July 1, 1946, and prior to consummation of sale are not included in the appraised value aforesaid but are offered for sale as a part of the unit for an additional consideration equal to the cost thereof to Owens-Illinois Glass Company.

In connection with the sale of the property and additions and improvements thereto above described, Owens-Illinois Glass Company will assign or cause to be assigned to the purchaser thereof for the consideration hereinafter set forth, all its rights in and to the following machinery and equipment leased from Hartford-Empire Company situate on said premises on July 1, 1946, to-wit:

4—4 head I S machines with feeders, revolving tube drives and motors, and variable speed drives and motors

1—5 head I S machine with same

2—36" x 74' lehrs, gas fired with top vertical discharge, motor driven steel plate exhaust fan, and all regular equipment

The consideration to be paid by the purchaser to Owens-Illinois Glass Company for the assignment of its rights in the leased machinery aforesaid shall be cash in such an amount as will reimburse Owens-Illinois Glass Company for a fair proportion of any and all payments made in connection with said leased machinery by Kimble Glass Company or Owens-Illinois Glass Company which may be considered as costs of installation, advance payments for minimum annual royalties, license fees, parts, insurance and taxes.

In the event of such sale, possession will be delivered not later than six months after the consummation of such sale to a purchaser approved by the said Court.

Address all inquiries to

Owens-Illinois Glass Company
Attention: F. G. Morfoot
P. O. Box 1035, Toledo 1, Ohio

ALKALI ABSORPTION OF FIRECLAY CHECKER BRICK . . .

(*Continued from page* 127)

to 2200 deg. F. This treatment caused the outer surface of the three used specimens to become vesicular and expand, the amount of expansion in thickness being given in Table II. The unused brick NA-1183 showed no change. These data indicate that the expansion occurs by heating to some temperature between 1900 and 2200 deg. F. It is to be noted that the tank operators estimated that the gases heated the brick in the top of their checker setting to approximately 2200 deg. F.

TABLE II—CHANGE IN WIDTH OF USED AND UNUSED BRICK UPON HEATING TO 2200 DEG. F.

Sample	Change
NA-1183, unused	No change
NA-1184, used	2.12% expansion
NA-1185, used	8.81% expansion
NA-1186, used	3.65% expansion

From these data it was concluded on a temporary basis, subject to additional study for thorough confirmation, that a) brick in the top of a checker setting of a glass tank will not show marked absorption of alkalies when the temperatures are sufficiently high to cause a glass or glaze to form on the surface; b) that in lower portions of the setting or the tops of settings where a glaze is not formed, the alkalies will be absorbed rather deeply into the brick; c) that the depth of absorption and amount of absorption would probably decrease progressively as the temperatures of operation are lower, and d) that if brick which have been in the lower part of the checker setting and so have absorbed quantities of alkalies are cleaned and replaced higher in the checker setting, that there is danger of bloating of the surface and possibly even failure of the checker brick due to deformation under load if temperatures above 1900 deg. F. are encountered.

It may be stated that the greatest danger to any checker setting occurs when accidents happen, such as damper trouble or instrument failure, that throw the furnace off schedule for temperature or time, or when personnel is negligent and does not follow established schedules. At such times, temperatures in the upper part of the checker setting may not be much higher than normal, but those in the lower parts of the setting become excessively high. These abnormal conditions, even though existing for a short time only, will cause serious failure of the checker setting and may not leave positive evidence that such high temperatures existed.

From these data, it has been concluded that if checker brick are to be removed from a checker chamber of any type of regenerative equipment, cleaned and put back into the setting, they should be examined for alkali absorption. If this absorption has progressed to a depth of ⅛ in. or more, such brick should be deemed unsuitable for this use and new brick put in their place. This would hold true particularly in those cases where high temperatures are encountered in the checker setting, 2000 deg. F. and above, or where such temperatures may occur during periods of unusual operation.

Courtesy of Sharpe, Inc.

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MANY leading manufacturers have shown preference for Pennsalt Hydrofluoric Acid for polishing fine cut glassware. It has proven its dependability by fulfilling the most exacting requirements.

In addition to etching and polishing glassware, Pennsalt HF is valuable in frosting decorative glassware and electric light bulbs, pickling stainless steel, cleaning castings, improving the quality of glass makers' sand and other important industrial raw materials, and in the preparation of fluorine compounds.

Pennsalt HF is available in strengths of 30%, 52%, 60% and 80% for domestic users; 71-75% for export. Strengths above 60% shipped in steel containers, weaker strengths in rubber drums. Write us for full details.

ANHYDROUS HF was first produced commercially in our Easton, Pa., plant. It is used as an alkylation catalyst in production of high octane gasoline. Also used in production of organic fluorine compounds, synthesis of other organic compounds, preparation of high purity inorganic fluorine compounds. Shipped in cylinders and tank cars.

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CHEMICALS

PENNSYLVANIA SALT MANUFACTURING COMPANY
1000 Widener Building Philadelphia 7, Pa.

RECENT TRANSLATIONS OF RUSSIAN PAPERS . . .

(*Continued from page* 131)

the new method. Uniform thickness and freedom from striae are essential. A blank 272 mm. (10.7 in.) in diameter was cut for every 250 mm. (9.8 in.) reflector.

An elevation of the "cup" is shown in Fig. 1. The dimensions are given in millimeters. The bottom of the cup has an exact parabolic shape. At its lowest point a hole connects the inside of the cup with the air outside; when the glass circle sags, the air under it escapes through this hole. Flanges along the rim of the cup insure an exactly central position of the blank. The material of the cup is cast iron.

The cup is placed in an electric furnace provided with good heat insulation and pyrometers. The temperature of the furnace and the cup is raised to 250°C (482° F.), the cup is taken out and its inside surface covered with lubricant.

Two lubricants were used. One was suspension of 50 parts of kaolin in 150 parts of water. The kaolin previously was comminuted and passed a sieve having 2500 holes per sq. cm. The suspension was sprayed onto the cup. The main advantage of this lubricant was its long service time—up to 2 months during which the cup was in permanent use. The other lubricant was graphite. The inside of the cup was rubbed with it. The initial performance of graphite was even better than that of kaolin but it was necessary to repeat the rubbing every 5 to 6 days.

After the application of the lubricant the cup is returned to the furnace, and the temperature is raised to 650°C (1200°F). Then it is again taken out, and the glass blank is placed on it. The cup + blank is pushed back into the furnace, heated to 650°C and kept at this temperature for 10 min. Then the furnace with the cup and glass is allowed to cool. The schedule of cooling is roughly that standardized for the given Fourcault glass, but the optimism treatment depends on the dimensions of the furnace and on the position of the cup in it, and should be worked out for individual conditions.

When the temperature decreases to about 300°C (570°F), the cup is taken out, the reflector transferred into a pre-heated asbestos box, and their ways part: the cup's temperature is raised for another run, and the reflector continues to cool off. In this manner more reflectors are produced by means of one cup.

The rear (convex) side of the reflector is ground manually. Only a layer 0.1-0.15 mm. (0.004-0.006 in.) thick needs to be taken away. Then the final polishing is carried out. The front (concave) side of the reflector must be treated with great caution during the whole procedure; it should not be damaged, touched by hand, etc.

The new process takes 20-30 hours as against 136 hours required by the old procedure. Silvering of the mirror etc. did not change.

The characteristic data of reflectors made according to the new process are—average coefficient of reflection 0.85
average focal distance 106 ± 1 mm.
aberration errors not above 2 mm.

The process is in constant use in three glass factories in U.S.S.R.

RUSSIAN GLASS PRODUCTION IN 1945

A note in *Stekol'naya i Keramicheskaya Promyshlennost* ("Glass and Ceramic Industry") 1946, No. 1-2, p. 13, contains relative data on the glass production in U.S.S.R. Taking the production in the first quarter of 1944 for 100, that in the subsequent quarters was 86, 156 and 175 in 1944, and 157, 204, 238 and 275 in 1945. The increase was due primarily to the work of the restored factories in the liberated regions: in the last quarter of 1945, 56% of the total production originated in these plants.

Only deficiencies are given in absolute units. It is stated that, if the average yield of ordinary glass were as high as 50%, the consumers would have received 1,800,000 sq.m. (about 20,000,000 sq. feet) more of window glass. An equally great addition to the customers' window glass would have accrued if the breakage remained within the permissible limits.

BALL BROTHERS ACQUIRES MILLVILLE PLANT

It has been announced that Ball Brothers Company has acquired an additional glass manufacturing plant located about 60 miles southeast of Philadelphia in Millville, New Jersey. The plant was formerly operated by the partnership of Friedrich and Dimmock, succeeded by Friedrich & Dimmock, Inc., since purchase by Ball Brothers Company.

E. Arthur Ball, Vice President of the company, will head the Millville organization as President and General Manager and will, for the present time, devote the major part of his time to its operation.

Products fabricated by the newly acquired plant include glass tubings and rods of all sizes and lengths, spun glass fibers, glass wool mats, specially blown glass, capillary hair tubings, industrial and chemical glassware, glass ampules, vacuum tubes, flasks and other glassware for scientific and pharmaceutical use.

Facilities are now being increased for the production of spun glass retainer mats which are manufactured by the plant to exact specifications for use in high grade storage batteries such as are employed in submarines and aircraft.

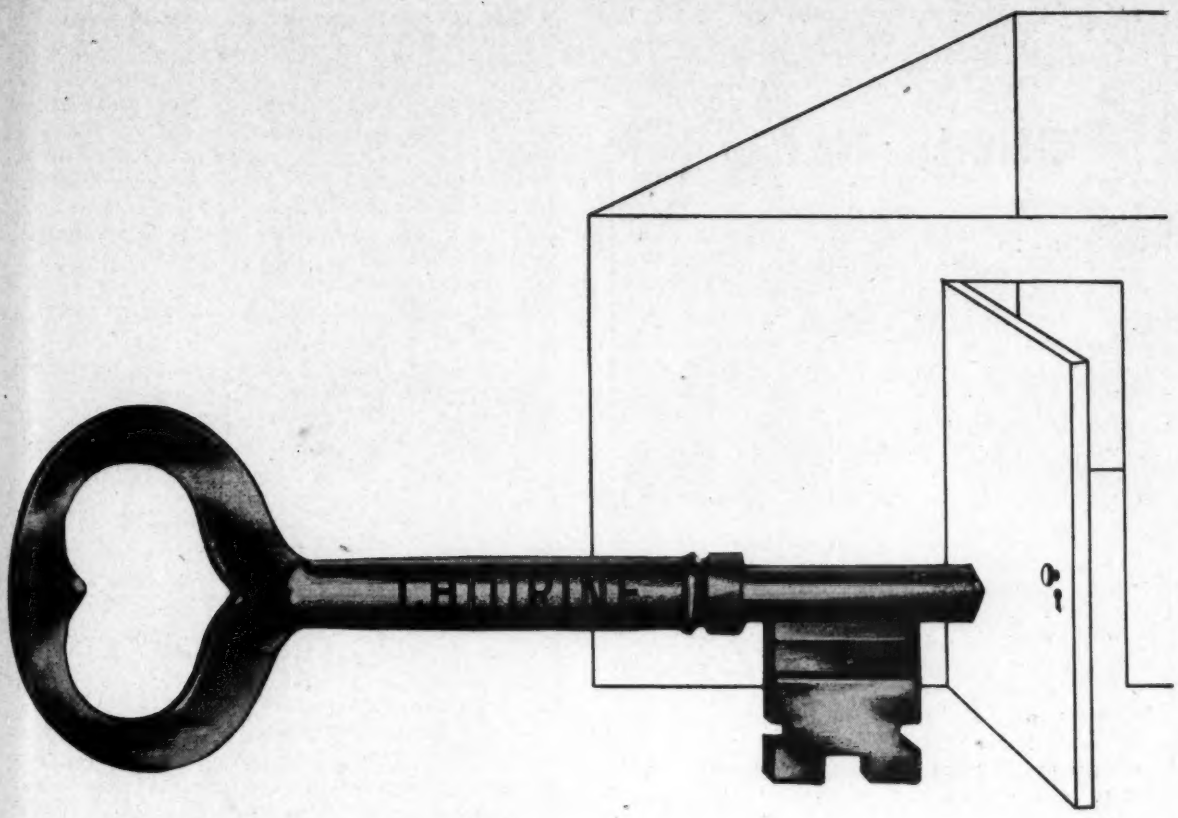
PITTSBURGH PLATE APPOINTMENT

According to a recent announcement, Pittsburgh Plate Glass Company has appointed Samuel L. H. Burk as Director of Industrial Relations.

Associated with Atlantic Refining Company for the past twelve years, Mr. Burk has served with the concern as Director of Organizations and Methods. In that position, he was in charge of the firm's industrial engineering, office methods, organization and policy and job evaluation programs.

During the war years, Mr. Burk was given leave by the firm to serve in consultant and executive capacities with three war emergency agencies. He also served as Director of Industrial and Public Relations with Triumph Explosives Incorporated.

Mr. Burk is the author of numerous papers on personnel administration and related subjects and co-author of "Manual of Job Evaluation." Prior to the war, he taught industrial relations management at the University of Pennsylvania's graduate school.



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Research is finding Chlorine a useful key to the synthesis of other chemicals, especially organic materials. Wider and wider becomes the range of the services that Chlorine renders to the development of our civilization. It is an important agent in the manufacture of the newer insecticides, bactericides and weed-killers—and it's finding new uses in the fields of solvents, protective finishes, synthetic detergents and plastics. Chlorine continues to be important for sterilizing food equipment . . . bleaching pulp, textiles and other products.

Wyandotte Chemicals Corporation—one of the world's great producers of Chlorine—is alert to the promise of this chemical. So users of Chlorine can continue to look to Wyandotte for expert, up-to-the-minute service. A request for advice about the adaptability of Wyandotte Chlorine to *your* purposes will receive careful attention.

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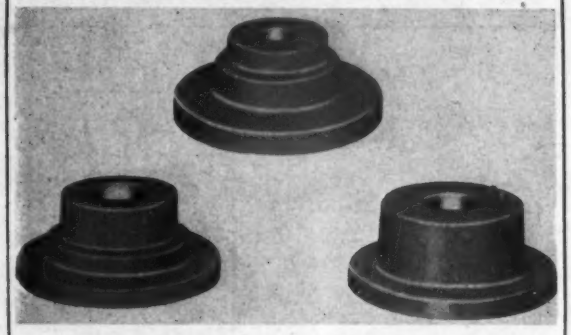

Like all Gunite glasshouse castings Standard grade A is used for guide rings because it is best adapted to this particular purpose.

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Engineered to withstand stresses far beyond the requirements, and built of corrosion-resisting materials, N & F Bins last from one generation to the next with practically no maintenance expense incurred.

Our catalog explains the construction of N & F Bins and pictures many typical installations. Ask for it.

THE NEFF & FRY CO.
CAMDEN, OHIO

NEFF & FRY STORAGE BINS

OPTICAL SYSTEM FOR TELEVISION SETS . . .
(*Continued from page* 129)

ing equipment had to be installed to produce them. The concave face of the mirror is ground and polished and then aluminized in such a way that the reflectivity will be as high as possible. The problem of aluminizing surfaces as large as these in quantity, and also of producing an aluminum surface of the necessary durability was not simple, the company states.

The majority of television manufacturers who are planning to produce projection receivers appear to be ready to use a screen about 18 x 24 inches in size. For this size of projected picture the set would contain a 5″ diameter picture tube, a 14″ diameter spherical mirror and 9½″ diameter corrector plate.

To obtain reflectivity, one side of the mirror is next aluminized in a vacuum chamber. A finished mirror is shown above receiving visual examination by television worker. Note how his face is enlarged but also distorted by the mirror. These aberrations are corrected by the correcting lens shown in the next picture.

To produce the mirror and corrector plate in quantity, American Optical Company has established a separate division in its Southbridge plant for the manufacture of the television optics.

Another contribution to the development of television receiving sets is the result of a war-time invention for producing glareless glass which makes possible the reception of clearer, sharper television pictures according to H. R. Moulton, Assistant Research Director of American Optical Company.

The successful removal of light-consuming reflections from a cathode-ray tube's glass face which serves as the screen of a direct-viewing home television receiver, has been obtained through a new glare-removal technique which also produces images of greater clarity if applied to the optical system of another kind of television receiver—the projection type.

The technique, was developed during the war to increase the efficiency of such military optical instruments as binoculars which gained over 60 per cent in light transmission when reflections were reduced, thus enabling an observer to see distant targets better in dim light.

Disclosing that reflections are removed by directly coating the face of the television tube with a secret chem-

Aberrations introduced into television images by the enlarging reflecting mirror are "unscrambled" by a correcting lens, one of which is being inspected after polishing operations.

ical composition, it is not necessary to disassemble the tube for the coating process or to apply the coating in the vacuum chambers used in earlier glare-removing techniques.

The coating, it is explained, improves the reception of television pictures by: 1. Reducing reflections in the glass face of the tube caused by light sources in the room housing the receiver. 2. Reducing the intensity of false images caused by reflections from the outer surface of the image-producing fluorescent screen in the tube, thus increasing the sharpness of the images. 3. Reducing light losses from reflections, thus increasing the amount of light transmitted.

PHILADELPHIA SECTION PLANS SPRING MEETINGS

The Philadelphia Section of the American Ceramic Society has completed its plans for its Spring Meetings.

On March 27 there will be a joint meeting with the Pennsylvania Ceramic Association at which the principal speaker of the evening will be Dr. Woldemar A. Weyl, Professor of Glass Technology and Director of Glass Science, Inc. Dr. Weyl will present a paper on "Some Practical Aspects of the Surface Properties of Glass." He will discuss some questions and problems which are of interest to the manufacturers and users of glass in the form of containers, fibres, laboratory ware, mirrors and miscellaneous products.

The annual meeting of the Section has been announced for May 22. The election of officers will take place and Dr. F. H. Norton, Professor of Ceramics, M.I.T., will present a paper on new developments in rare refractory oxides.

In late June, on a date not yet established, there will be held the first annual Philadelphia Section picnic at a local country club.

• Following the regular February Meeting of the Board of Directors of Thatcher Glass Manufacturing Company, Inc., Franklin B. Pollock, President, announced that Lewis H. Durland had been elected to the Board of Directors. Mr. Durland is Assistant Treasurer at Cornell University.

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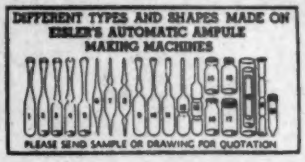
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PERMANENT SUSPENSION

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PITTSBURGH 30, PENNA.

MECHANISM OF THE REDUCTION OF LEAD IN GLASS . . .

(*Continued from page* 126)

positively charged area is unstable, and in order to restore electrical neutrality either the Na^+ or the Pb^{2+} must be deposited in atomic form. Since the first and second ionization potentials of the lead atom (7.38 and 14.96 electron volts, respectively) are higher than the ionization potential of the sodium atom (5.11 electron volts) it is not unreasonable to assume that restoration of electrons would be in the reverse order of their removal. The lead ions would thus leave the glass structure by becoming lead atoms, and the newly-arrived Na^+ would take the place of Pb^{2+} in the interstices of the glass network, two sodium ions for each lead ion, each of the former held by one single-bonded oxygen.

The two electrons required by each Pb^{2+} are supplied by the external circuit which has a charge of electrons on the cathode. These in turn are replaced from the excess negative charge in the glass near the anode, an excess which results from the migration of Na^+ to the cathode. This excess is represented by the unsaturated single bonds of the oxygen ions which formerly held the sodium ions in the glass. In order to restore electrical neutrality in the anode area of the glass the excess single-bonded oxygens become atoms by the loss of two electrons from each O^{2-}. These electrons travel to the anode and are supplied to the external circuit to replace the two electrons acquired by each lead ion at the cathode.

It is therefore incorrect to assume that oxygen ions migrate through the glass to the anode and are there converted to atomic form. Such migration is unlikely because (1) the oxygens are firmly bonded to the silicons as part of the network, and (2) the ionic radius of oxygen is probably much too large to permit migration through the interstices of the silicon-oxygen network.

Reduction of lead in glass by electrolysis is then explained solely by migration of sodium ions (also lithium and potassium in some glasses), which replace lead ions in the cathode area of the glass, while each excess single-bonded oxygen ion in the anode area, no longer needed because of the migration of sodium ions to the cathode, becomes an oxygen atom by loss of two electrons, which in turn replace the two electrons taken from the external electrical circuit by each lead ion at the cathode when it becomes a lead atom. There is thus a continuous flow of electrolytic current even though sodium alone is transported through the glass.

The same reasoning explains the blackening of the glass surface when bombarded by electrons thermionically emitted from the plates of a rectifier tube. The glass surface becomes the cathode because of the impingement of electrons, and lead is reduced by the same mechanism as above.

• American Potash & Chemical Corporation has reported net earnings of $1,514,105.29 during 1946, compared with $1,176,366.01 in 1945. These earnings amounted to $2.87 a share for 1946 against $2.23 a share in 1945, an increase of about 30 percent.

• The Board of Directors of the Pennsylvania Salt Manufacturing Company has declared a dividend of 30 cents per share on the $10 par value capital stock, payable March 15, 1947, to shareholders of record at the close of business March 3, 1947.

O. G. BURCH NAMED O-I GENERAL RESEARCH DIRECTOR

Oscar G. Burch has been appointed to the position of General Research Director of Owens-Illinois Glass Company to succeed Urban E. Bowes, who served in that capacity since 1935. Mr. Bowes asked to be relieved of his research duties to devote full time as head of the Kaylo Division of Owens-Illinois.

In addition to his new duties, Mr. Burch will for the present be acting Research Director for the Glass Container Division.

Mr. Burch has received his B.S. and M.S. degrees and from 1929 until 1931, was sales engineer for the Great Western Electro-Chemical Company. He became research chemist for the Owens-Illinois Glass Company at Alton, Illinois in 1931 and in 1937 assumed the position of Manager of the General Research Laboratory in Toledo, a position which he continues to hold.

WYANDOTTE RESEARCH DEPARTMENT HOLDS STAFF MEETING

The Wyandotte Chemicals Research Department was host to the District Managers of the Michigan Alkali Division of the company at its second annual staff meeting. During the three meetings, featured talks were given by staff members of the Research Department and by Bert Cremers, Vice President in Charge of Sales, Michigan Alkali Company; Mel Clark, newly appointed Manager of soda ash, caustic and bicarb sales; Howard Roderick, Manager of chlorine, calcium carbonate and organic sales; and W. F. Torrey, Vice President.

During the technical sessions, detailed accounts were given by Research Department members of the properties of new glycols and mixed glycols and of the new Wyandotte synthetic detergent. Further technical information was given by Dr. J. J. Schaefer and by Dr. Thomas H. Vaughn.

Technical talks were presented during the sessions which related to the various divisions of the Wyandotte Chemicals Research Department; namely, analytical, bacteriological, chemical engineering, cleaning and sanitation, inorganic, industrial, laundry, library, organic, patent and physical.

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WANTED—CERAMIC ENGINEER. Large middlewest glass factory wants Ceramic Engineer with experience in all glass decorating processes, petrography, refractories and lehrs. Position entails full responsibility for product development, process standardization and trouble shooting in these particular phases of manufacturing. Salary depends upon training and length of experience. Write details of training, experience, age, marital status, etc. Reply Box 52, c/o The Glass Industry, 55 West 42nd Street, New York 18, New York.

WANTED

Copy of Textbook of Glass Technology by Hodkin and Cousen. Will pay full price. Address Box 54, c/o The Glass Industry, 55 West 42nd Street, New York 18, New York.

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GLASS SPECIALTIES

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Solid Pot Opal Blown Sheet Glass
Flashed Opal Blown Sheet Glass
Colonial Antique Colored Glass
Heat-Ray Resisting (Cool Glass)
"TWIN-RAY"—the scientific illuminating glass.

HOUZEX

L. J. HOUZE
CONVEX GLASS CO.
POINT MARION, PENNSYLVANIA
New York Office: 110 West 40th Street
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"IF IT'S MADE OF GLASS, ASK US FIRST"

1907 was a great year . . .

and 1932 was one of diversified events!

In 1932 the Reconstruction Finance Corporation measure was passed providing for emergency financing of banking institutions, railroads and agriculture. Manchuria was declared independent.

In 1932 Banner Lime celebrated its Silver Anniversary, marked by outstanding results and increasing use as a superior material for building construction, for agriculture and for industry. Today, due to its continued popularity, demand still exceeds supply—but we are bending every effort in production so that requirements of our customers for Banner Lime may soon be satisfied. National Mortar and Supply Company, Grant Building, Pittsburgh, Pa. Established 1907.

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In four essential industries—agriculture, building, glass and steel—lime and lime-stone are essential.